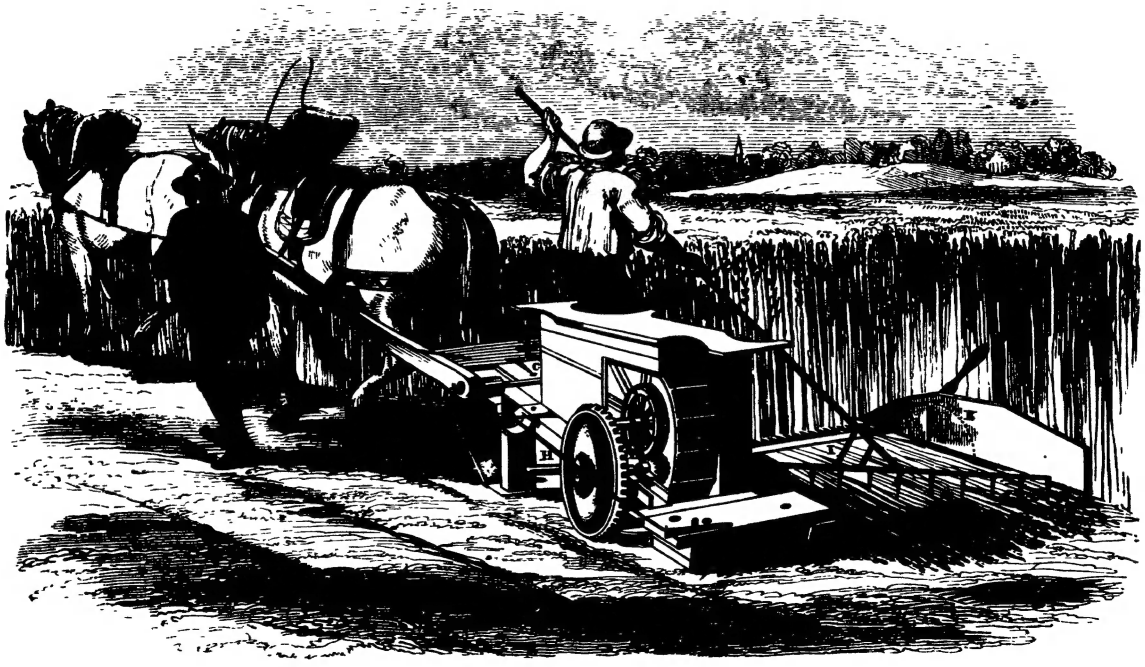

RUDIMENTARY TREATISE

ON

AGRICULTURAL ENGINEERING.

With Illustrations.

BY

G. H. ANDREWS, C.E.

VOL. III.

FIELD MACHINES AND IMPLEMENTS.

JOHN WEALE, 59, HIGH HOLBORN
1853.

TO

JOSEPH GIBBS, Esq. M.I.C.E.

THESE THREE LITTLE VOLUMES

Are Respectfully Dedicated

IN ACKNOWLEDGMENT OF THE MANY FAVOURS RECEIVED FROM HIM

BY HIS OBLIGED SERVANT,

THE AUTHOR.

PREFACE.

THIS little Work on Agricultural Engineering was undertaken for the purpose of bringing, at a small cost, before the farmer such information as he would most likely need in reconstructing his farm-buildings, and in choosing his machinery and implements.

These objects the Author has endeavoured to carry out, and judging from the sale of the previous volumes, he flatters himself not unsuccessfully.

Although there are a variety of machines and implements that have been, and are occasionally used, of which no mention has been made; yet he believes that no machine or implement has been omitted that may be considered to be in ordinary use, and its efficiency and utility generally acknowledged.

In the case where a great number of different makers manufacture one kind of implement, of course it would be

impossible to mention more than one or two, who have by superior workmanship and greater attention to details, gained a reputation for it.

In conclusion, the Author begs to tender his sincere thanks to those gentlemen who have kindly supplied him with information upon the different subjects connected with the work, and more particularly to Mr. Garrett of Leiston, Mr. Howard of Bedford, Mr. Crosskill of Beverley, Mr. Hornsby, Jun., of Grantham, Mr. Haslem of Reading, and Mr. Woolnough of Leiston.

The Elms Cottage, Brentford, Middlesex,
April, 1853.

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INTRODUCTION.

SINCE the time when these little volumes were commenced the great question that agitated the agricultural world, that is, whether corn should be for ever imported into this country free of duty has been finally settled. Free-trade is now the law of the land, and the British farmer has to compete with the corn-growers in all the countries of the world, some of whom have been especially favoured by Providence, in the situation of their land, their climate, and the natural fertility of their soil. Freight only is in favour of the home-grower, and this is now reduced so low as to be an exceedingly small matter in the question; a hundred miles of ocean may be traversed as cheaply as one mile on the turnpike-road, and a farmer, whose market is a dozen miles from his homestead, is not much more favourably situated than he who grows corn on the banks of an American river.

Farmers, we all know, have not been getting the monstrous profits their opponents would pretend; in fact, the tenant-farmer has not, for many years, been in a position to make more than a very moderate per centage on the capital he has embarked in agricultural operations, and a small remuneration for his own labour.

It becomes a matter of no small importance, then, that he should consider now in what direction he must look for means to compensate him for the privilege he has hitherto

enjoyed, that he may compete successfully with his more favoured rivals. An improved system of agriculture I conceive to be the principal point towards which attention should be directed; if he can at the same time get his landlord to lower his rent, so much the better; but the lowering rents will not give anything like the advantage to be gained by an improved system of cultivation, to be carried out by reconstructing all the buildings on a proper plan, giving the maximum accommodation for the minimum cost, economising labour and promoting the welfare of the stock, draining the whole of his lands in a perfect manner, employing all the most recently-invented machines for diminishing the cost of working his land, and, lastly, though by no means least, farming only just so much land as he has capital to work to the highest pitch of which it is capable. I believe if this be done under a good landlord, where the rent is equitably adjusted, the cultivation of the soil and the production of human food, may still be a profitable occupation.

The great difficulty the agriculturist labours under is, to know what plan to adopt when so many are offered; he hears of wonderful discoveries being made which are entirely to supersede old and established plans, new methods, new manures, new courses, and new crops, and before he has time to make a trial, he finds they are abandoned: they did not answer. First, he is told to sow an abundance of seed, then that everything depends on not sowing one grain more than is required for a plant; or he is told he cannot have his tiles laid too deep, and an equally eminent authority informs him that shallow drainage is much the best. The poor farmer gets bewildered with the thousand and one schemes put before him for his advantage, and consequently continues to go on in the old way, preferring that to the plans of those persons who only benefit the science of agriculture by publishing the history of their errors.

Next to the introduction of artificial manures (which has enabled a large amount of land to be covered with heavy root crops, that could not else have been so used), the great advances made of late years in the construction of agricultural machinery and implements has been of the first importance; all the operations necessary to produce a fine tilth, to clean the land from weeds, and to facilitate the operation of housing, being now effected in a much superior manner, and at half the time and cost formerly required. It is in this direction particularly that the agriculturist should seek for greater assistance.

First, it is of importance that a steam-engine, or other motive power, be adapted to do all the heavy work of the farm, and all the duties that possibly can, be thrown on the back of this cheap, never-tiring, and constant helper. The first outlay for engine and boiler of six horses power will not be more than the cost of six horses, and the price of fuel is now reduced to an exceedingly low limit, Messrs. Hornsby having been some time working at 5lb. of coal per horse-power per hour, and latterly have considerably diminished that; and when Mr. McConnell's improvements are applied, I have no doubt but that a still further reduction will take place; an immense saving will of course be made on farms of any magnitude by the introduction of steam machinery.

A system of agricultural railways, also, would be of importance to the farm; and that all farms will, in a few years, have a railway laid from the homestead through the lands, I have not the least doubt, as the carrying so heavy an article as manure on to the field is one of the most costly duties on the farm. The same railway would also facilitate the bringing back the produce of the fields to the homesteads, and afford means for getting the business of the farm concentrated at the steading.

Now, if the gauge of the farm-railway be the same (4 feet 8½ inches) as the great lines of the kingdom, why should not

branch lines be constructed from the railway to the farms along the side of the roads? or on any other convenient plan? so that the farmer might be able to get a truck from the head of his field on to the main line of railway, and thus convey it to a near, or most distant market, without the trouble and expense of frequent shifting.

I do not consider the railway system of this country half developed until there are railways instead of parish roads, instead of green lanes, and instead of the road at the field's-head.

Of course it is not to be supposed that these railways are all to be constructed in the same substantial manner in which the great trunk-lines are made, the cost must diminish from the passenger line progressively with its traffic and importance, until it is laid down the middle of the field as by Mr. Croskill at 3*s*. 6*d*. per yard.

CHAPTER I.

MACHINERY AND IMPLEMENTS FOR DRAINAGE.

PREVIOUS to any operations being commenced for cultivating land, it is necessary to thoroughly free it from water. Land is injuriously affected by water in several different ways, and different machines and implements are used under different circumstances.

1st. In the case where land is situate so low as to be permanently or occasionally flooded, by freshes from rivers running through it, high tides, or other such circumstances.

2ndly. From the nature of the subsoil being so impermeable as not to allow the water that has fallen from the clouds to descend through it, consequently the land, or cultivated soil, remains for a long time in a saturated and overcharged state, utterly unfit for growing plants.

3rdly. From water rising upwards through the soil as springs, caused by the pressure or height of the water in some other place; and 4thly. Where the upper surface of the soil is beaten by the action of the rain into a puddled covering, in which all the interstices are stopped up, and consequently no air can get down to the plants.

In the cases of land being subjected to be flooded by the sea or rivers, the operations are on a much larger scale than the others, and should always be executed by the Civil Engineer. Many works of this description have been executed in England, and the whole country of Holland is protected from such inroads by an immense number of

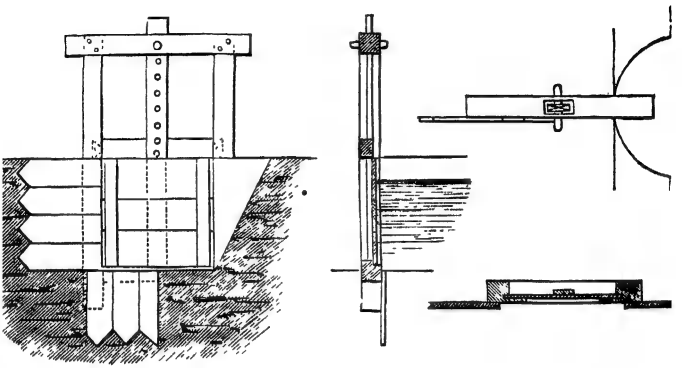
most admirable and scientific works. In England the district called the Fens is situated in the manner alluded to, and the whole owes its cultivated existence to the efficiency of the great drainage works there executed, the foremost of which is the Great Bedford Level. The works usually constructed in these cases are, First, an arrangement of earth-banks for keeping the waters into their proper channels; secondly, sluices and gates for allowing the waters contained within the banks to run out to the lowest level that can be obtained; and, thirdly, engines and machines for lifting out the water that remains, and that is lower than the natural outfall, into higher channels. Sluices (or hatches, as they are generally called in England), are gates for regulating the flow of water; when of small dimensions, they usually consist of two upright pieces of timber, the lower ends of which are tenoned into a sill, and the upper end secured in the same way into a flat piece of timber.

On the inside face of the two upright pieces are cut grooves perfectly true. In this groove, a gate made of a series of boards, of the width between the grooves, and fastened to an upright piece of timber, as shown in fig. 1. This gate slides up and down in the grooves as required. The centre upright has a number of holes bored through it, and the cross-piece or cap, one. When the gate has been lifted up to the necessary height, an iron pin is passed through the hole in the stem of the gate, and into the corresponding one in the cap; it is thus held in any position that may be thought necessary.

When these works are large and the gates become heavy, it is necessary to contrive some means of lifting them, as it could be no longer done by merely hoisting them with the hand. A rack is then placed upon the stem, and a pinion properly fixed upon the cap, the teeth of which gear with those which form the rack, a winch is applied, and the gate is raised or lowered with great facility.

When a very large quantity of water has to be dealt with, a series of gates are placed in a row; they are constructed in

Fig. 1.

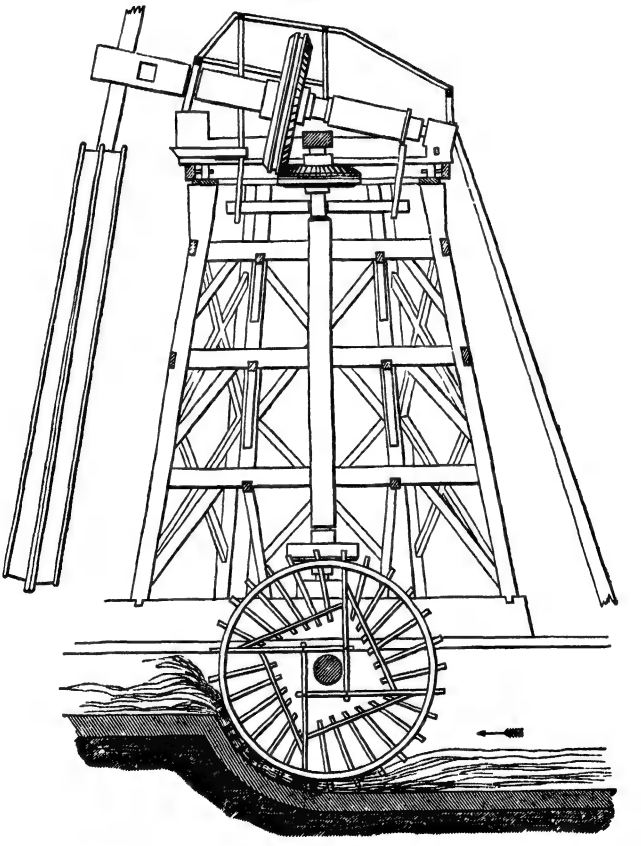


a manner precisely the same, only the framing has to be braced and secured in a stronger manner.

A series of small hand-gates, called shuttles or flashes, are sometimes placed on the top of the larger gates. The principal conditions to be observed in the construction of these works are, that they shall be an effectual guarantee against floods, or any sudden rise of the water in the channels. They should be as permanently constructed as possible, and be made to work easily, which they very seldom do, and a great deal of hammering and heaving with crowbars takes place when they are required to be opened; this is more especially the case when the gates are made too wide, which they often are; great care should also be taken in making a sound junction with the banks and the wings of the sluice-frames above, so that no water may find its way through from the back. As much water as will, having flowed through the sluices, the next operation is to lift the remainder up to that level, that it also may be got rid of. A great variety of machines have been used for this purpose in ancient and

modern times, but those now generally in use are either the Dutch Scoop Wheel or the Cornish Pumping Engine. Throughout Holland scoop-wheels may be seen in constant

Fig. 2.



SECTION OF DUTCH DRAINING WINDMILL AND SCOOP-WHEEL.

use, draining the polders. They are chiefly driven by windmills. Fig. 2 is a section of one of these draining machines,

showing the manner of driving the wheel. The mill is constructed similar to an ordinary flour-mill, but the upright shaft is carried down to the bottom floor, where a bevel wheel is placed upon it, and another on the shaft of the scoop-wheel, to which it communicates the motion. The scoop-wheel, or flash-wheel, as it is often called, is constructed of a series of flat blades, radiating, but not from the centre of a shaft similar to ordinary water-wheels, the blades work in a chase which they accurately fit, and in their revolutions force the water before them from the lower to the higher level, as shown in the annexed section.

These machines are not economical or effective in lifting the water above the centre of the axle, the loss of water between the circumference of the blades and the race increases when the speed of revolution diminishes, but this loss may be reduced to the lowest point by making the blades rectangular, and of a width equal to double their height. In the fen districts of Lincolnshire, Mr. Glynn has erected some powerful machinery of this nature. One of these, erected on the Ten-mile Bank, near Little Port, in the Isle of Ely, is driven by an 80 horse-power engine, with a wheel 40 feet diameter. The Deeping Fen, near Spalding, with an area of 25,000 acres, is drained by two engines of 80 and 60 horse-power. The 80 horse-power engine works a wheel of 28 feet diameter, with float-boards 5½ feet by 5 feet, and moving with a velocity of 6 feet per second on the average, when the engine has its full dip; and consequently the sectional area of the blades lifting the water is 27½ feet. The quantity discharged per second is 165 cubic feet, or about 4½ tons, raised 5 feet in height.

On the bank of the Old Bedford river, which empties into the Ouse at Salter's Lode Sluice, is the Manea and Walnea District Engine. It is of 60 horse-power; the diameter of the flash-wheel 32 feet, width of floats, or lodes, 2 feet 9 inches, making 3½ revolutions in a minute. It drains

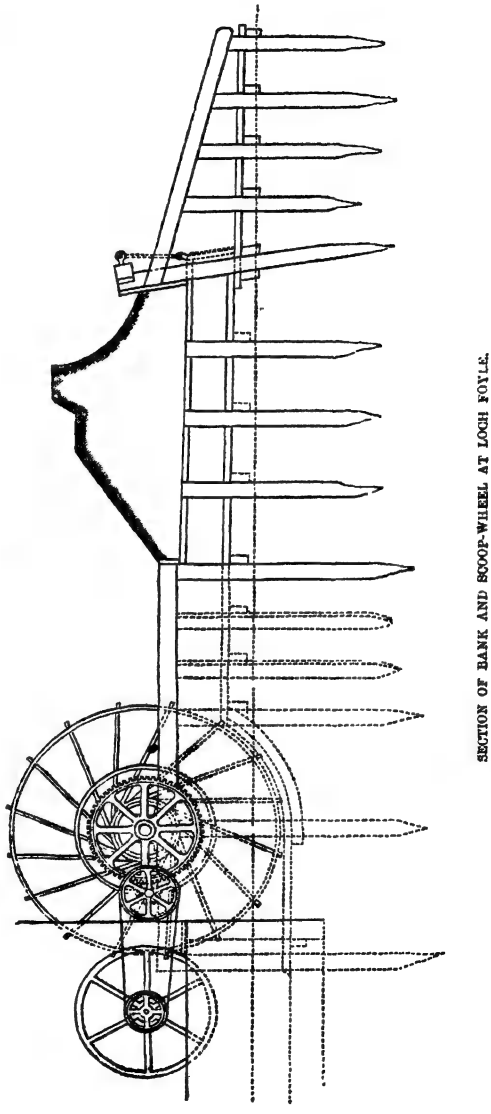


Fig 3.

SECTION OF BANK AND SCOOP-WHEEL AT LOCH FOYLE.

8685 acres, the cost of coals being 7*d.* per acre. The Sutton and Mepal Engine is built a little higher up on the same bank, and throws its water into a canal called the Counter Drain, which empties itself into the Bedford river. It is 80 horse-power; the diameter of the wheel being 32 feet, and the width of the lodes 4 feet, making $3\frac{1}{2}$ revolutions per minute. It drains about 10,348 acres, at a cost of $7\frac{1}{2}d.$ per acre for fuel, &c. The District Drainage Tax is from 4*s.* to 6*s.* per acre.

Fig. 3 represents a section of the bank, and the arrangements for driving the scoop-wheel, erected at Loch Foyle, by Joseph Gibbs, Esq. The wheel in this case was constructed of wrought iron, and was 18 feet in diameter.

The engines are usually provided with three boilers; a 40 horse engine has three boilers of 30 horse-power each, two being used while one is being cleansed or repaired. It is proved by practice that two boilers of 30 horse-power will generate steam for a 40 horse-power engine, much more economically than one 40 horse-power boiler, caused chiefly by the furnace not being required to be so often disturbed in the one case as the other. The cost of a steam engine, including the building and fixing, for purposes of drainage, is about 100*l.* per horse-power.

The engines we have hitherto described are all employed in lifting water, by giving motion to a scoop-wheel, but in many cases steam engines have been erected for the purpose of lifting water by means of pumps. Of these there are a great variety. We can have only space here to glance at the most remarkable that have been invented for the purpose, and that have been found in practice to answer. By far the largest and most justly celebrated of these are the engines erected for the drainage of the Great Lake of Haarlem in Holland.

As I have before observed, the low lying lands of Holland are all drained by the use of scoop-wheels, worked by water

power. These mills are the pride of the Dutch engineers, and certainly they are very fine machines and exceedingly effective, and until it was proposed to drain the Haarlem lake, were considered to be a far superior method to any other in use; but two English engineers, Joseph Gibbs and Arthur Deane, both having had considerable experience in the Cornish engine, seeing that such a machine would be far better adapted for the purpose, undertook the very difficult task of proving that fact to the Dutch commission of engineers who had been appointed to report upon the best method of draining the lake; and after a long and tedious inquiry, slow even for Dutchmen, they at length came to the determination to adopt the plans of the English engineers, and one scarcely knows which feat deserves the most credit, the persuading the Dutchman to give up his wind-mill and scoop-wheel, or the actually getting the water out of the lake (as by this time it is).

Messrs. Gibbs and Deane's plan was to construct three large engines on the Cornish principle, but of peculiar design, particularly suited to the character of this work.

The area of the lake of Haarlem is equal to 45,230 acres, and its average depth about fourteen feet, the cubic contents of the whole being equal to about 800 millions of tons of water.

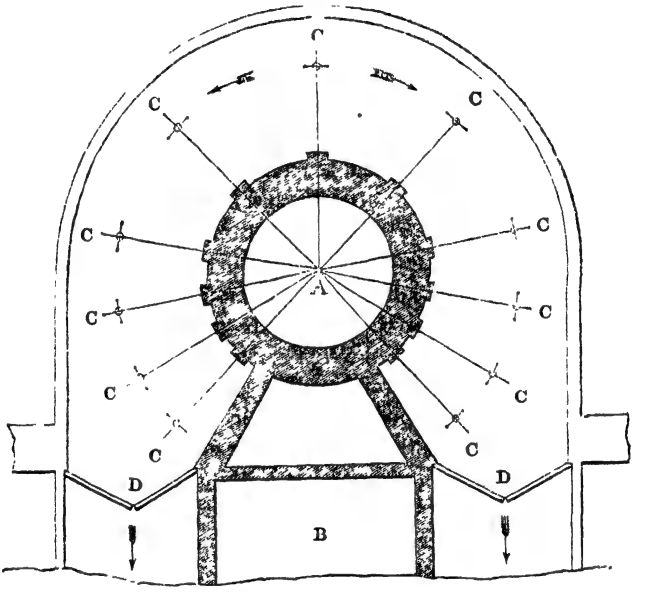
The longest side of the lake is parallel with the sea, and separated from it only by a narrow strip of land; the three engines were placed at different parts, so as to have suitable outfalls. They are severally called the Leeghwater, the Croquis, and the Van Lynden; these names given to the engines were those of three celebrated engineers who had at various times interested themselves in the drainage of this great lake.

Of these three engines the "Leeghwater" was first erected, with suitable houses and pumping machinery. The first step in this work was to construct an earthen dam of a

semicircular form, enclosing about 1½ acre of the area of the lake, and adjoining its bank. The space inclosed by this dam was then cleared of water by a small steam-engine, and the foundations for the houses and machinery commenced. These foundations consist of 1400 piles, which were driven to the depth of 40 feet, into a stratum of hard sand. Upon these piles, and at the depth of 21 feet below the surface of the lake, a strong platform was laid, and upon this a wall, pierced with arches, was constructed, at the distance of 22 feet from the intended position of the engine-house. Upon this wall a thick flooring of oak was laid, between the wall and the engine-house. The pumps rest upon the platform, beneath and opposite to the arches, and their heads pass through the floor just described, standing about 3 feet above its level. Into the space left between the engine-house and outer wall, the water raised by the pumps is received, and discharged from it on either side of the boiler-house, through sluice gates, into the canals conducting to the sea sluices. The general arrangement of the engine, boilers, pumps, and sluices will be understood from fig. 30, in which A represents the engine; B the boiler-house; C C the pumps; and D D the sluices through which the water is discharged. The engine has two steam cylinders, one within the other, united at the bottom, but with a clear space of 1½ inches between them at the top under the cover, which is common to them both. The large cylinder has an annular piston, both pistons are connected by one main piston-rod (of the internal cylinder) 12 inches diameter, and four small rods (of the annular piston) 4½ inches diameter each, with a great cap or cross head, having a circular body 9 feet 6 inches in diameter, and formed to receive the ends of the balance beams of the pumps. The pumps are eleven in number, and each of them 63 inches in diameter, with a cast iron balance beam turning upon a centre in the wall of the engine-house, one end of which is

connected with the great cap of the engine, the other to the pump rod. Each pump rod is of wrought iron, 3 inches in diameter, and 16 feet long, with an additional length of 14 feet of patent chain cable attached to the pump piston.

Fig. 4.



PLAN.

The steam and pump pistons have a stroke of 10 feet in length; each pump is calculated to deliver 6·02 tons of water per stroke, or 68·22 tons for the eleven pumps. The quantity actually raised is found to be about 63 tons. The action of the engine is as follows:—The steam being admitted, the piston and great cap are thereby raised, and the pump pistons make their down-stroke. At the top of the steam-stroke a pause of one or two seconds is made, to

enable the valves of the pump piston to fall out, so that, on the down-stroke of the steam piston, they may take their load of water without shock. In order to sustain the great cap and its dead weight during this interval, an hydraulic apparatus is brought into use, which consists of vertical cylinders, into which water is admitted, forcing upwards two plunger holes which sustain the cap, the water being prevented from returning by spherical valves fitted at the lower parts of the cylinders. The arrangement of the two steam cylinders is adapted in order to bring the load under immediate command, the varying character of which would otherwise require occasional alteration of the dead weight to overcome it, which would involve great delays and inconvenience. By the use of the two cylinders, the dead weight raised by the small piston does not usually exceed 85 tons, the extra power required being derived from the pressure of the return steam at the down-stroke upon the annular piston. A skilful regulation of the expansion and pressure of steam in the small cylinder thus enables the engine-man to provide for all cases of difference of resistance without the delay of altering the dead weight. Respecting the power of the "Leeghwater," it appeared from experiments conducted by a sub-committee of the commission, that the duty was equal to that of raising 75 million lb. one foot high by the consumption of 94 lb. of good Welsh coal, and exerting a net effective force of 350 horse-power. The lift being 13 feet, the engine works the eleven pumps simultaneously, the net weight of water lifted being 81·7 tons, and the discharge 63 tons per stroke. When the site of the lake is cultivated, the surface of the water in the drains will be kept at 18 inches below the general level of the bed, but during floods the waters of the upper level of the country will be raised above their usual height, and the lift will be increased to 17 feet. To test the power of the engine to meet these cases, the eleven pumps were worked simultaneously without

regard to economy of fuel, and 109 tons net of water were raised per stroke to the height of 10 feet. The boilers of the "Leeghwater" engine are five in number, cylindrical, and each 30 feet long, and 6 feet in diameter, with a central fire tube 4 feet in diameter. Under the boilers a return flue passes to the front and then divides along the sides. Over the boilers, and communicating with all of them, is a steam chamber 42 feet in length, and 4 feet 6 inches in diameter, from which a steam pipe 2 feet in diameter, conveys the steam to the engine. The consumption of fuel is 2½ lb. of coals per horse-power per hour, with working with a net effect equal to the power of 350 horses. The cost of the "Leeghwater" and machinery was 21,000*l.* It has been calculated that the entire cost of the works for draining the lake will be 100,000*l.* less than would have been incurred by adopting the ordinary system of steam-engines and hydraulic machinery, and 170,000*l.* less than the expense of applying the system of windmills hitherto prevailing in Dutch drainage. The annual cost of the three methods is thus estimated:—By three engines such as the "Leeghwater," 4500*l.*; by windmills, 6100*l.*; and by ordinary steam engines, 10,000*l.* Besides the ordinary plans of pumps attached to Cornish engines, there have of late been introduced a great variety of pumps, among the most remarkable of which are Appold's and Gwinne's pumps.

Mr. Appold's constituted one of the principal attractions in the department of machinery in motion at the Great Exhibition of 1851, and might be seen constantly delivering, at a considerable elevation, a powerful stream of water, which was not a little refreshing during the hottest portion of weather. Mr. Appold's pump is similar in every respect to the mill known as Whitelaw's mill, but the action is reversed: in the former, a column of water descending by pressure on the horizontal wheel, causes it to revolve, and

it is then used as a motive power; but in the latter case, some other motive power is used to cause the horizontal wheel to revolve, and lift the water, it thus becomes a pump of considerable power. Mr. Appold's wheel was only 12 inches in diameter; it received the water on each side, through apertures of 6 inches diameter, and had a central disc or diaphragm perpendicular to the axis, intersecting the vanes, forming, as it were, a double wheel, revolving between two cheeks, that projected from opposite sides of the reservoir.

The curvature of the vanes was found to be a matter of considerable importance, as it would discharge, when so constructed, more than double the quantity of water in the same time, and with the same power, as one constructed with straight vanes.

A trial was made with Mr. Appold's pump against two others of the same size, the one with straight vanes, inclined at an angle of 45 degrees, and the other with radial arms—the following results were obtained:—

	REVOLUTIONS PER MINUTE.	GALLONS RAISED PER MINUTE.	HEIGHTH RAISED.	USEFUL EFFECT.
MR. APPOLD'S WHEEL	792	1664	18 feet 8 in.	·649
" "	788	1236	19 " 4 "	·680
INCLINED VANES	694	560	18 " 0 "	·394
" "	690	736	18 " 0 "	·434
RADIAL VANES	624	369	18 " 0 "	·232
" "	720	474	18 " 9 "	·243

THOROUGH DRAINING.

The water at the outfall having been lowered either by deepening the channels or lifting the water by some of the means we have described, another department of draining is commenced, called thorough draining. This consists in laying across the land at intervals, and at a few feet below

the surface, lines of tiles constructed of such shapes as that, when they are laid end to end, they form a continuous pipe, and being made of porous material the water passes through them, and in at the joints, then finding a ready course through to the main drains. These pipes are made of a variety of shapes, sometimes forming a perfect pipe in one piece; and at others they are composed of two pieces, the upper one shaped like a horse-shoe and laid upon a flat piece called a sole. These are very rarely used now, a circular pipe being found to be the best form and the most easily constructed.

The tiles with soles were the first used, and, as no machinery then existed for constructing them, doubtless that form was best as it was easily made, being two flat pieces made like plain tiles first, and then one piece was bent over a saddle-shaped block of wood, and after being dried was burnt in that shape, and when laid in the ground formed an excellent drain; but as machinery came into use other forms were adopted, and the sole or bottom of the tile became a part of it.

A variety of ingenious machines have at various times been patented for constructing drain tiles, and although many of them exhibit great mechanical ingenuity and are very interesting, we cannot afford space in this little book to describe more than one or two that have come into general use: of these the most known are the Tweedale machines, Beart's, Ainslie's, Hart's, and Clayton's.

The last-mentioned machine I can recommend as one of the most efficient and generally useful of them all. I know many persons who use them, and generally they give satisfaction. They are made entirely of iron, and adapted to manufacture tiles either vertically or horizontal; which is an important advantage, as in the manufacture of large pipes they never keep their shapes when passing over horizontal rollers, consequently they have a flat side, and

from being so misshapen will not fit properly when laid end to end.

Most tile machines act upon the principle of forcing the clay through discs, in which are openings cut to the shape of the tile, as seen in cross section. The various ways in which this simple operation is performed, constituting their peculiarity, Clayton's is simple, strong, and compact, and equally well suited for all kinds of work.

The clay is contained in two large cylinders attached to the frame by swing brackets, so that no delay takes place by filling, one cylinder being replenished while the other is being discharged. The internal shaft-work is formed of wrought iron; the clay is forced out of the cylinder through the perforations in the discs by a piston, which is acted upon by gearing so arranged that it takes twenty-five turns of the winch to force the piston down and only four to lift it up again. The cylinders are fitted with perforated metal plates or gratings, of various sizes, for screening the clay from all stones, roots, or other extraneous matter that would be injurious to the formation of the tiles. Two men and a boy will make with this machine, if the clay be in the best order, about 10,000 feet of pipe per day, working piecework.

A great variety of machines on a similar principle to Clayton's are manufactured by various persons, all constructing the tiles by forcing clay through discs: in some the cylinders are horizontal, and in others vertical.

A great impetus was given to the manufacture of drain tiles by machinery by the invention of a tile-making machine by Mr. Beart, of Godmanchester, Huntingdonshire. This gentleman, a very ingenious and excellent mechanic, constructed a tile-works on a large scale, and conducted all his operations in a very superior and methodical manner. The consequence was an immense saving in cost of manufacture. A statement by Mr. Beart of his machine and the system pursued will be found in the "Journal of the Royal

Agricultural Society," vol. ii. part 1. A saving of 2*s.* 6*d.* per thousand was at once made by the introduction of the machine, and a greater facility given for the execution of a larger amount of work with greater regularity. This machine was not for making pipe tiles, but intended to facilitate the making of horse-shoe tiles, which are formed of one piece bent as before described over a piece of wood called a horse.

MACHINES AND TOOLS FOR LAYING TILES.

Only one machine is in use at the present time for effecting this object. This is the one known as Fowler's draining machine, and is the invention of John Fowler, jun., of Bristol, who received a silver medal from the Royal Agricultural Society of England, at the meeting at Exeter in 1850, for his invention. It was described by the inventor as a mole or plug plough for making a hole in the soil at depths varying from two to four feet, and at the same time drawing into the hole thus made any draining material, such as earthen or wooden pipes, straw, ropes, &c.

There is an apparatus attached for raising or sinking the plough, so as to lay a level drain under an uneven surface: it is drawn by the power of a windlass, and one horse's power exerted there will move the plough a yard in twenty seconds at a depth of 2 feet 6 inches. Three horses, four men, and six boys will keep two ploughs going, and do 4000 feet in a day at a depth of 3 feet.

A hole requires to be dug for the machine at every hundred yards, or six for an acre.

This implement, as might be expected, was an object of much attention at the meeting, and various were the speculations of visitors and the judges as to the difficulty it would experience in laying tiles in stony and gravelly soils. The machine was again exhibited at the Great Exhibition in

Hyde Park in 1851, having been considerably modified and strengthened. Public trials were also made with it on Wormwood Scrubs.

I am not aware of its being in use anywhere at the present time, nor do I think it in its present state at all adapted for laying tiles on the generality of soils. There are situations, doubtless, as bogs, where a machine of this character might be used with advantage; but wherever it is the soil must be free from stones, either in beds or as boulders, the upper surface of the land very even, and the tiles of first-rate quality. The principle upon which the machine acts is very simple. The reader will imagine a deep knife fixed under the beam of a wheel-plough; at the bottom of this knife a pointed piece of iron fixed horizontally; at the back of this piece of pointed iron is attached a chain or rope, and upon this rope are threadled, one after another, lengths of the pipes or tiles to be laid; a strong windlass attached to horse-gear is placed at a distance in front of the plough, and a chain from the barrel of the windlass is attached to the end of the plough-beam. A hole is then dug to allow the deep knife and pointed iron to enter the ground at the intended depth; the plough is then drawn forward, the knife cutting the earth through and the iron point making a passage for the string of tiles to follow. When the plough has arrived at the windlass the rope is hauled out, and the tiles of course remain properly laid, end to end, and with greater accuracy than could be done by the ordinary means. To ascertain the state in which the tiles are left by the machine, a trench has been afterwards cut and the tiles examined, and invariably they have been found to be very properly laid.

It appears, therefore, that as far as the actually laying tiles at moderate depths in certain soils, this machine answers the purpose intended; but there are so many circumstances that would interfere in different localities,

as to render it very doubtful whether it can become a machine of general application.

GIBBS'S DRAINING MACHINE.

Some few years since a machine was placed in my hands by Mr. Josh. Gibbs, an eminent civil engineer, which he had himself invented and constructed, for the purpose of laying tiles without the necessity of opening the ground to a greater width than the chase in which the tile itself had to be laid. I tried a variety of experiments, and it gave the greatest possible satisfaction. An experienced drain-tile layer, who assisted in them, assured me he could lay tiles as well with its assistance as when the ground was opened wide enough for him to stand on the bottom of the opening.

Of course it could not be expected that this, the first attempt at the construction of such a machine, should be perfect, and answer equally well in all situations; but of this I am certain, that had the inventor followed up the subject a little further, a very great benefit would have been confered on agriculture generally by giving much greater facility for the laying deep drains; and I am still in hopes, when less pressed with other business, he will make perfect this admirable machine.

DRAINER'S TOOLS.

The ordinary manner in which the drain-tiles are laid is by cutting an opening in the ground, gradually narrowing in towards the bottom so as to require as little soil as possible to be removed. To effect this in the best manner, the tools or spades must be made in sets, the smallest being no wider than the tile to be laid.

These are made by most implement-makers of the most approved forms to suit the different depths. Mr. Clayton, of

the Atlas Works, Dorset Square, whose tile-making machine we have before alluded to, manufactures very superior tools for cutting the gripes in different soils, either clay or gravel.

These tools are made with ground-polished blades, and upon scientific principles as to shape; they are formed with cycloidal blades, which gives strength and lightness, and produces the best form of cutting-edge, as well as allowing the clay to leave the tool more easily than is the case with those made in the ordinary manner. Besides the tools for excavating, one or two others are necessary for cleaning out the bottom and laying the tiles; but however well the tiles may be laid, the work is inefficiently done if the drains have not been properly set out and the levels accurately laid.

CHAPTER II.

THE PLOUGH.

THE plough is the most important and valuable implement, and the one most generally used in agricultural operations; being the fundamental implement, it is common to all ages and countries. Mention of it is made in the earliest writings upon agriculture; indeed, its introduction must have been coëval with the first attempts at cultivating land and raising corn. The tillage of land is supposed to have been first practised in imitation of the effects produced from deposits of sand and mud by retiring rivers after floods and inundations. These effects must have been observed by the inhabitants, as herbage springs up spontaneously, as soon as it is left dry, and subjected to the heat of the sun's rays.

The peculiar characteristics of certain portions of Egypt would favour the hypothesis that corn was first cultivated in that land, as it is spoken of in the earliest times as so

fruitful in grain as to be considered the granary of the adjacent countries.

Sir Isaac Newton and Stillingfleet both considered that corn was first cultivated on the banks of the Nile in Upper Egypt, where the waters only occasionally covered the land, leaving it ample time to profit by the deposits of mud and sand, and put forth the plants peculiar to it. The inhabitants, observing this hint from nature, that nothing more was necessary than to scatter the seed in this soil, and that it would then vegetate and bring forth fruit in abundance, endeavoured to imitate it by cleaning the ground of weeds, and mixing the rich sedimentary deposit of the river with pure sand.

To effect this at all, an implement of some kind must have been used, and that was the first plough. Antiquaries have agreed that this must have been a sort of pick, and little else than the merest scratching of the soil would be necessary under such circumstances as they were placed in. Various representations are in existence of very early ploughs of this kind.

As other lands gradually became cultivated, an improved form of plough would doubtless be constructed to meet the requirements of local circumstances, as agriculture was carried to a great pitch of perfection in Egypt. Of this the numerous traces remaining to this day bear ample testimony, such as the banks and canals in lower Egypt, especially in the Delta, traces of no less than eighty canals exist for the purposes of draining and irrigating. We find the plough (1 Sam. xiii. 20) had a share and coulter, indicating a considerable advance in the construction of an efficient implement. From Egypt the art of cultivating the soil found its way into Greece, the aboriginal Pelasgi being civilised by colonies from that country. The little that is known of the practice of the Greeks is obtained from the works of Hesiod, called "Works and Days." He was contemporary with Homer, and culti-

vated a farm at Askra, at the foot of Mount Helicon in Bœotia, and grumbles like any modern farmer at the badness of his land, which, he says, is too hard in summer and too soft in winter, and never very good at any time. I should fancy his occupation was a piece of good rank stiff clay, as little loved at the present time as in the days when he wrote. He describes the ploughs of his time as being composed of three principal parts: the share-beam (which is to be made of oak), the draught-pole, and the plough-tail (to be made of elm or bay), and the whole to be securely fastened with nails and pegs; he also recommends that a spare plough be kept ready to be used in case of accidents.

Roman Ploughs.—Of these a great variety must have been in use, as they are mentioned by various Roman writers on agriculture, as having peculiar characteristics adapted to the particular soil or description of work to be done. Mr. Adam Dickson, in his work on the husbandry of the ancients, says, "It is probable that I shall be considered as very partial to the ancients, if I do not allow the moderns to excel them in the construction of their ploughs. We are not indeed so well acquainted with the ancient ploughs as to be able to make a just comparison. I shall only observe, that from the few passages in the rustic authors concerning them, it appears that the ancients had all the different kinds of ploughs that we have now in Europe, though not perhaps so exactly constructed. They had ploughs without mould-boards, and ploughs with mould-boards; they had ploughs with coulters, and ploughs without coulters; they had ploughs without wheels, and ploughs with wheels; they had broad-pointed shares, and narrow-pointed shares; they even had what I have not yet met amongst the moderns, shares not only with sharp sides and points, but also with high-raised cutting tops. Were we well acquainted with the construction of all these, perhaps it would be found that the improvements made by the moderns in this article are not

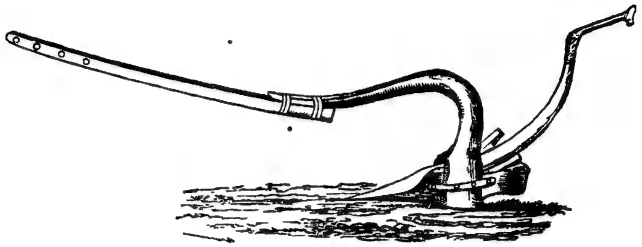
so great as many persons are apt to imagine." Without quite following Mr. Dickson to the full extent of his admiration of ancient implements of tillage, we must admit that very considerable perfection had been attained in the construction of the plough, judging by the numerous descriptions found in the works of the different authors. Cato mentions two ploughs, one called the Romanicum, proper for stiff land; and the Campanicum, as adapted for a light soil. Varro mentions a plough which must have been similar to an ordinary modern ridge-plough; it was used for ploughing in seeds, and was fitted with two mould-boards. Pliny speaks of fitting a piece of board to an ordinary plough, in order to adapt it to the purpose of ploughing in seed. Palladius speaks of a plough for ribbing up land when the water lays much in the furrow, in wet seasons.

Ploughs answering to the descriptions of the classic authors may now be found in different parts of Italy and Sicily; and in various parts of Europe and Asia are ploughs still in use of the most primitive forms, and very much inferior to what I imagine the ancient Roman ploughs to have been, judging by the descriptions handed down to us. The Araire of the South of France is an implement of this rude kind, merely dividing the soil, and pushing it in front of it. The plough of Asterobothnia, in Scandinavia, is often drawn by one man, and is little more than one of the ancient scratching-tools first used in Egypt, and represented upon the images of Osiris. The plough of the Morea of Greece is similar to the fluke of an anchor, and is drawn by two asses or one horse. The Syrian, the Persian, and the Indian and Chinese ploughs are all of the same character, being merely scratching implements, and scarcely deserving the name of ploughs.

The annexed cut represents the modern plough of Castile. It is engraved from the original sketch kindly lent me for this purpose by my friend, Mr. J. Telbin, and was drawn from nature by him, while making sketches in Spain for his

Panorama of the Campaigns of the Duke of Wellington. I have preferred giving a cut of this plough to any other, as I could rely on its accuracy, and it is interesting, as showing the extremely low state of agriculture in Spain at the present

Fig 5.



moment, it being impossible that any efficient system of husbandry can be carried out where such a rude implement as this forms the principal feature; and it is not only in the plough that the modern Spaniard is so far behind, even the ancient Roman farmer, much more the modern scientific agriculturist, for Mr. Telbin described to me the manner of thrashing, as he saw it practised in Spain in 1850, and which is not one bit in advance of the old custom of treading out the corn by the feet of oxen. The plough was first introduced into Britain by the Romans, and there are many rude drawings in existence, representing different kinds of ploughs. Some of these are very similar to the Castilian specimen shown in the cut, while others, used by the Saxons, are shown as having wheels, and in several cases the horses are represented as fastened to the plough by their tails, a barbarous custom that existed in Ireland as late as 1634, for an act of the Irish Parliament, 11 & 12 Car. II., c. 15, entitled an "Act against plowing by the tayle and pulling wool off living sheep," sets forth, that "Whereas there have been for a long time practised in this country a barbarous custome of plowing, harrowing, drawing, and working with horses

and other animals by the tayle, whereby the breed of animals in the kingdom is much impaired, and great cruelty perpetrated, these practices were henceforward to be considered illegal, and the offender subjected to fine and imprisonment."

No mention is anywhere made in the Bible of ploughs being drawn by any other animal than the ox; an old British law forbade the use of other animals than oxen for drawing ploughs, and the early English ploughmen were compelled by law to be as able to make their own ploughs as to guide them. The implement under these circumstances naturally remained for a long time in an exceedingly rude state, and it was not until the commencement of the seventeenth century that anything like an effective implement was constructed. About that time greater attention was paid to agriculture in England, and Dutch engineers came over to drain the fen districts. These intelligent people brought with them the design of that known as the Rotherham plough, so called because the first known to have been constructed in England was made at Rotherham, by Jos. Foljambe, under the direction of the celebrated Walter Blythe, whose works we have often elsewhere alluded to. For this plough a patent was obtained in the year 1730.

Other accounts state that this plough was made by Lammis, upon strictly mathematical principles, which he had learned in Holland—and others, by a person of the name of Pashly, who was ploughmaker to Sir Charles Turner, at Kirkleatham. The son of this last-named person established a manufactory for this plough at Rotherham, and he also is considered by some to have been its original inventor. The design of this plough had, either from Holland or England, found its way to America, and the honour of its invention is claimed by the people of that country. President Jefferson presented an account of the principle for constructing a mould-board, first to the Institute of France, and afterwards to the Board of Agriculture in England, as an original discovery in mathematics.

The Rotherham, or, as it was sometimes called, the Dutch plough, was constructed of wood, with the exception of the coulter, draught-irons, and share; the mould-board was plated with iron, and the sole was also made of the same material.

The fame of this plough at length extended into localities remote from where it was originally constructed; and as no very defined form had yet been laid down for it, it may easily be imagined, that in the hands of inferior and prejudiced workmen it degenerated into a clumsy and inefficient implement, while in other and better hands it was improved and altered to suit local circumstances. Arthur Young mentions a plough made by an ingenious blacksmith of the name of Brand, and which he stated as being superior to any other in the kingdom. The Rotherham plough, having found its way into Scotland, was brought under the notice of a most ingenious mechanic, named James Small, born in Berwickshire, in the year 1740. This man bestowed a great amount of attention to the improvement of ploughs, and in the end was enabled to construct one upon a fixed principle, which gave it a permanent and uniform character. Small (remarks Mr. Slight) appears to have been the first who gave to the mould-board and the share a form that could be partially imitated by others, whereby following his instructions, mould-boards might be multiplied, each possessing the due form which he had directed to be given to them. Small's improvement chiefly consisted in giving that most important feature of the implement, the mould-board, a mathematical outline which enabled it to turn the furrows over in an equal and regular manner.

OF THE PARTS OF THE PLOUGH.

The frame is the centre portion of the implement, to which the mould-board, beam, handles, &c., are affixed; it is now nearly always constructed of iron, and although of different

shapes, according to the peculiar description of plough, its use is always the same, that is, a solid structure upon which to build up the other parts of the instrument, the mould-boards, handle, beam, sole, &c., being screwed to it in such a manner as to be easily adjusted, or removed if necessary.

The Beam is a strong bar of iron, or beam of wood, to which the animals are yoked, one end of which is securely fixed to the plough frame, the coulter is also attached to it.

The Stilts, or Handles, as the latter name implies, are the long pieces of iron or wood held by the ploughman during the operation of ploughing, and which are so arranged as to give him the greatest possible control over the implement in directing its course, and preserving the depth and accuracy of the work. The one on the right hand side, as the ploughman stands at work, is called the little stilt; this in many ploughs is a continuation of the beam and body of the plough in a straight line.

The left hand one is called the great stilt; both these are attached securely to the plough frame, and often are continuations of the beam, and separated by the stretcher, bolts, and stays.

The Bridle, Muzzle, or Plough Head, is a contrivance placed at the outer end of the beam, and to which the horses are yoked. It is constructed in a variety of ways, but the object sought to be obtained in all is the same, that is, to give a ready means of adjusting the line of draught so as to cause it to work steadily, and at the proper depth, by giving it, as it is called, more or less earth; this is effected by means of a moveable portion of the plough head called the *hake*, and which allows of the draught-shackle being altered vertically, more upwards or downwards, or laterally to the right or left. The bridle is differently constructed by different makers, but the usual plan is to make the hake in the arch of a circle, and with a pin secure it in its place, while the draught-chain is regulated in notches cut in the fore part of it.

The Coulter is a large knife, made very strong, of iron and steel; it is an important part of the implement, and requires considerable care in its adjustment. Its use is to cut or sever vertically the seam or piece of earth through which the plough is to pass; it is made sharp on the front side, and so strong as not to give or bend in any way while in use. The side of the coulter next the land is perfectly flat; the other side tapers towards the back. To give the necessary thickness and strength, it is attached to the beam of the plough by its upper end, which is made round for that purpose; it is not set perpendicular, but at an angle, generally of about 55° with the ground; but different kinds of land, and the same land under different circumstances, require the coulter to be set at various angles, sometimes very much forward, and at others so far back as to be slightly in the rear of the point of the share, the point being $\frac{3}{4}$ of an inch above the share, and slightly on the land side of it. The manner in which the coulter is secured to the beam is different in the various descriptions of ploughs. The ordinary old-fashioned plan is by a wedge; but this was very inefficient, difficult, and uncertain. Messrs. Ransome, and other makers, adopt a principle of adjustment which gets over much of the difficulty. Messrs. Hensman have a screw and lever, which is attached to the side of the beam; and thus the coulter is set more forward or backward as may be required.

The Sock, or Share, is that part which cuts the slice of earth horizontally; it is fixed into a projecting portion of the lower part of the plough body, called the *sole or slade*, which is a moveable piece secured to the under side of the frame.

Plough-shares are not always of the same form, being more or less curved on the face, and longer or shorter pointed.

Plough-shares were formerly made of wrought iron, but

in 1785, the late Robert Ransome, of Ipswich, obtained a patent for constructing "shares of cast iron."

This was a most important improvement, and caused all parts of the plough to be equally improved by the same gentleman and others; and in 1803, Robert Ransome still further improved the manufacture of cast iron shares, by applying a case-hardening process to them. They are now manufactured by the firm of Ransome & Co., of Ipswich, in large quantities. Their improvements consist in case-hardening the under side the thickness of $\frac{1}{10}$ or $\frac{1}{8}$ of an inch, thus resembling the effect of placing there a layer of steel. The lower part, from its hardness, wears slowly, while the upper part grinds quickly away. A uniform sharp edge is thus constantly kept.

The Mould-board is now invariably a plate of cast iron, screwed to the plough frame, and is also called the turn-furrow, or wrest.

This term originally applied to only a portion of the mould-board, and was probably the wrest of the ancient plough which turned aside the earth, after it had been cut by the coulter. The part called the wrest, in the Kentish plough, is simply a bar of wood.

The office of the modern mould-board is to receive the piece of earth upon its fore end after it has been cut by the coulter from the side, and from the bottom by the share, and then turn it over continuously to a fixed angle, which it does by its peculiar curved form, these curves being continued from the mould-board by the form of the box end of the share to its extreme point.

It is upon the correct form of this part of the implement that the accuracy, ease, and excellence of the ploughing will depend. The largest amount of attention, therefore, has been devoted to it; and desirable as it is that some fixed principle should be laid down as applicable to all forms of mould-boards, it has not as yet been accomplished, though

the principles by which it is governed have been investigated and discussed by a great number of scientific and talented individuals, from Small's time till now. Among these may be mentioned, Bailey, Gray, Jefferson, Clymer, Ransome, Wilkie, Rham, Slight, and others, who, though not arriving quite to the point required, have nevertheless, by their consideration of the subject, been able to lay the foundation for some rules that may soon be adopted for the production of a comparatively perfect form of this important part of the plough; not that it is likely that any one form will ever be the best for every description of plough, and for all the circumstances under which ploughs are used, as width and depth of furrow are not the only change of circumstances, and it is well known that a mould-board which exhibits an evenly-worn, polished surface, and all the marks of having been well adapted to its work, will, on being removed to another description of soil, exhibit quite the reverse features, and show its entire unfitness for the purpose.

It is impossible in the limited size of this book to enter at length on the details of the various forms of mould-board in use,—nor is it necessary, as this work is intended for farmers, and not ploughmakers; and parties purchasing ploughs of those persons who have obtained a character for the efficiency of their implements need not trouble themselves much about it, as they may rely upon such ploughs as are sold by Messrs. Ransome, of Ipswich, Howard, of Bedford, Busby, of Bedale, and many other persons, being constructed with every care and attention to all the qualities necessary to produce an implement thoroughly well adapted to its purpose. The repeated trials for the premiums offered by the Royal Agricultural Society have done much towards improving ploughs, and their results are the data which the agriculturist can study to increase his store of knowledge in this department of agricultural machines.

WHEEL AND SWING PLOUGHS.

Ploughs are divided into two classes respectively, called Wheel and Swing Ploughs.

Those of the former class are usually fitted with a carriage and two wheels to support the beam, which is then made to stand up at a considerable angle, and is secured to the upper part of the carriage, as shown in fig. 8; the body, frame, stilts, coulter, &c., being similar to a swing plough. The draught chain is attached to the centre part of the frame (which is called a gallows) between the two wheels, and should be at precisely the same spot as it is in the swing plough, the beam of which is always curved downwards to allow of it.

Ploughs with a wheel and a high gallows, are common in many parts of England, and are generally much preferred by the local farmers. Varieties of them may be met with in Norfolk, Essex, Berkshire, Wiltshire, and many other counties. The Kentish turn-wrest is one of the most celebrated of this description, but has its own peculiar turn, turson, or wrest. The Hampshire wheel plough is peculiar to some of the light sandy ground in North Hants, and has some peculiar (local) advantages. In North Wilts, in the neighbourhood of Chippenham, a wheel plough is used, and preferred to any of the long mould-board ploughs lately introduced; it is called *the Wiltshire Dilly Plough*. The best specimens of this are made by a very excellent and ingenious implement maker, named John Berriman, of Lyneham, the grandson of the original inventor. They are wheel ploughs, but are without the gallows or front carriage. I have not sufficient knowledge of this implement to be able to describe the peculiar qualifications it possesses to make it so great a favourite in its locality, but certain it is that this

homely machine is preferred to the most scientific modern ones. It is also extraordinary that a wooden mould-board is used for it, made of a thick block of apple or pear tree, and dubbed into shape with an adze, entirely guided by the eye; but such is the skill of the maker, and the experience acquired by constant practice, that a very perfect form is given to it.

Iron mould-boards are fitted to it, but they are not so well liked by those who use them.

A number of ploughs, of an intermediate character between beam and swing ploughs, have also been introduced. Some of these displayed great ingenuity in their construction; one class had wheels or a wheel attached to the plough frame, and was intended to decrease the friction of the spade or sole-shoe upon the surface of the ground while the plough travels; and although there is some degree of plausibility in the idea, the disadvantages of the old plan are not so great as the inconveniences of the improved one, consequently none of them have come into use.

The Beam Plough, with Land and Furrow Wheel, is a successful attempt at combining some of the advantages of both descriptions of ploughs into one. Many Scotch ploughs are now made in this way. The plan was not originally introduced in Scotland; nevertheless they are called the improved Scotch ploughs, though Scotch ploughmen will be found invariably to prefer swing ploughs to any other descriptions of the implement.

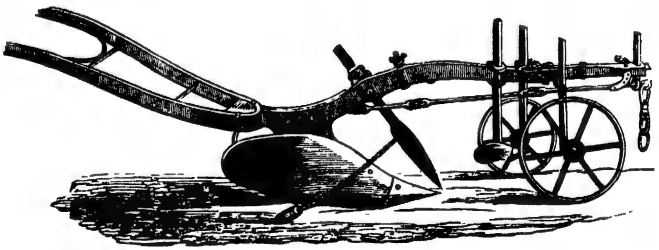
The Rutland Plough is a good specimen of one of this class. It was designed and originally introduced into the county from which it takes its name, by Richard Baker, of Cottesmere. These ploughs may be used as either swing or wheel ploughs, the wheels being easily removed. Nearly all the most approved English are now made in this manner.

Fig. 6 shows the manner in which the wheels era attached.

Of the comparative merits of wheel and swing ploughs, much has been said and written by many persons interested in the subject; and the balance of evidence thus given in favour of each is decidedly on the side of the wheel plough, or rather the land and furrow wheel-plough, one wheel of about 20 inches diameter running in the furrow, and the other one of about 12 inches running on the top of the unploughed land—the width of the wheels apart may be adjusted to suit any width of furrow.

HOWARD'S PRIZE PLOUGH.

This plough is made of iron (principally wrought), and is intended for ordinary ploughing, and is the smallest of a set of new ploughs recently designed and patented by G. J. and F. Howard. The new patent ploughs are made prin-



cipally of wrought iron, and are all improved from their prize ploughs. They are made of three sizes, marked for distiction X., XX., XXX., suitable for ordinary, deep, and extra-deep ploughing.

The improvements consist in greater elegance of design, more equal proportions, and the furrow-turners being made particularly taper and regular in their curve, and formed

upon exact geometrical principles. The furrow-slice is thus made to travel at an uniform rate, from its being first cut until left in its final position; the power required to work the implement considerably lessened, and the furrows laid more evenly, and in the best form for the reception of the seed, as well as working much cleaner upon land inclined to adhere, or load to the breast, or furrow-turner. The shares are fixed to lever nicks of wrought iron (made upon an improved principle), the raising or lowering of which gives the point greater or less "pitch," or inclination, as the share wears, or as the state of the land may require. The superiority of this lever neck over others is its great simplicity, and its being tightened at the end, instead of by a bolt through the side. When raised or lowered (which can be done instantly), it is secured in a series of grooves; the iron is thus brought into a state of tension, ensuring firmness as well as increasing the strength. The centre pin, upon which the lever works, is a fixture to the neck, and takes its bearing close to the head or socket of the share, so that the top of the share is not raised above or below the front of the breast, when moved into the higher or lower grooves. The lever neck has another great advantage over any other, —the accumulation of earth inside the plough, in most instances, renders the lever useless, as it cannot be moved without a great deal of trouble; but in this arrangement, by simply taking off the end next the neck, it may be at once disconnected from the plough, and anything preventing its free action removed. The axles of the wheels are upon a new principle, and are made so that no grit can enter, nor any oil or grease escape: the wheels, therefore, will wear much longer, the axles require little or no repairing, and the friction is considerably reduced. The mode of fixing the wheels is also peculiar; the holdfasts or clamps securing them are made to slide through a mortice formed in the beam, by which the width may be altered with greater

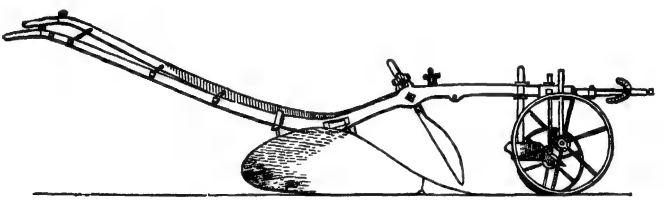
facility, besides dispensing with the old sliding axle, which was an obstacle in deep ploughing, and objectionable on dirty land, on account of the soil accumulating round it. The wheels of the method now adopted are brought opposite to each other, and the land-wheel may be expanded as well as the furrow-wheel. A draught-chain is adopted in all Messrs. Howard's ploughs, for the following reasons:—It removes all strain from the beam, and in land-work there is a steadiness of movement not to be found in ploughs which draw from the end of the beam; the line of draught is also more direct, consequently the power required is reduced. The handles and beam, which are of wrought iron, are made throughout in a piece, preventing their shaking loose, which is the case with most other ploughs made of iron. This latter improvement also prevents the accumulation of soil in the hinder part of the plough. Every part is so arranged that a ploughman can remove or replace the irons, subject to wear or breakage in the field, without the assistance of a mechanic. It can be worked either with or without wheels, or with one, as required. It may be had with breasts or furrow-turners of various sizes and shapes; broad shares may also be had with it, for paring stubble or turf, and others of triangular form, for subsoiling and ploughing between the rows of beans or root-crops. The skim coulter with which it is fitted is of great importance when ploughing ley ground and stubble; it precedes the common coulter, paring and turning into the furrow the herbage upon the surface, so that when the soil is turned over by the plough nothing of grass or weeds is left to grow out between the furrows; consequently the vegetable matter thus buried, instead of living upon the soil, decomposes and serves to enrich the land. It will also be found most useful when ploughing in dung, mustard, tares, &c., for with the addition of a "drag-chain," all may be turned in completely. —*Catalogue of the Royal Agricultural Society at Lewes.*

BUSBY'S PRIZE PLOUGH.

This plough had the council medal awarded to it at the Great Exhibition of all Nations in Hyde Park, in 1851.

It is manufactured by Mr. Busby, of Newton-le-Willows, near Bedale, Yorkshire, who has, by his intelligence and

Fig. 7



untiring industry in the manufacture of this and other implements, raised himself from an ordinary workman to his present position as the recipient of the highest honour it was in the power of the Commissioners of the Great Exhibition to bestow.

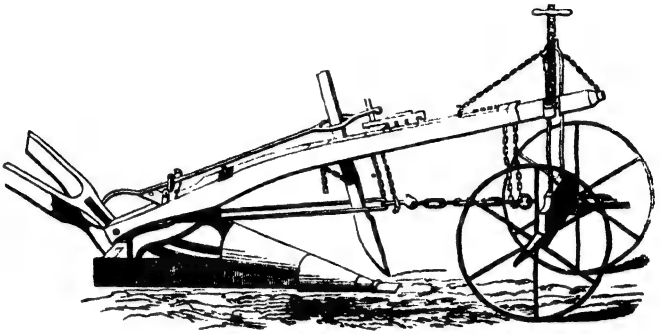
This plough has been introduced as the best specimen of a plough that is at present manufactured.

THE KENTISH TURN-WREST PLOUGH.

A stranger passing for the first time through the county of Kent could not fail to notice this remarkable machine. In appearance it is the ugliest, heaviest, and most cumbersome-looking machine to be found in all England, yet in practice I have no hesitation in saying that it is

one of the very best ploughs the agriculturist will ever meet with.

Fig. 8.



Boys, in his survey of Kent, gives the following dimensions and description of the implement:—

"It consists of a beam of wood, 10 feet long by 5 inches deep and 4 broad, behind which is a foot 5 inches by 3½ feet long, on the top of which the stilts, or handles, are placed; the foot is tenoned to the end of the beam, and mortised at the bottom to the end of the chep. Through the beam, at 2 feet 5 inches distance from the foot, is a sheath of oak, 7 inches wide by 1½ thick, which is mortised into the chep, or sole, in an oblique direction, so that the point of the share is 22 inches distant from the beam. The chep, to which the share is fixed, is 5 feet long, 4 inches wide, and 5 deep. The share is of hammered iron, weighs about 32 lbs., is 20 inches long, and from 4½ to 7 inches wide at the point. The upper end of the beam rests on a carriage, with two wheels, 3 feet 2 inches high. On the axle-tree is a gallows, on which is a sliding bolster, to let up and down. Through the centre of the axle is a clasp iron, to which is fixed a strong chain, called a "tow," that comes over the beam, so fixed as by means of notches (or a pin called a "chick"),

to let the whole plough out a greater length from the axle, thereby letting it down to a greater depth."

Marshall's description of this plough is too good to be omitted. He says it is almost impossible to describe this extraordinary production verbally, for its component parts, and the names assigned them, are equal to those of a ship. A North of England farmer, who has never been south of the Thames, would little suspect the purpose for which it is constructed; he would conceive it to be a carriage rather than a plough. It has a pair of wheels fully as large as the fore wheels of a moorland waggon, and behind them is dragged a long thick log of wood, which slides upon the ground as the hob or shoe of a sledge, with a beam rising high above it, which a small farmer of the north would be glad of as a gate-post; comprising in its various parts as much timber and other materials as would build a Highland cart. It is so peculiar an instrument as to be manageable only by a person who has been long trained to the use of it; and so liable to dislocation from a conflict of forces in its mechanism as to require continual nailing and tinkering on the part of its manager; and so unwieldy and rebellious on some of the hill-grounds which most require the turn-wrest form of tillage as to have been known to break away bodily from even the most careful and practised control. Yet, in spite of its many and enormous disadvantages, it possesses such eminent adaptation to the chalky hills and absorbent plains of Kent, and Surrey, and West Sussex, as to have maintained its place in the firm and general esteem of the farmers of these districts age after age, since at least the beginning of the seventeenth century, to the utter neglect of the great multitude of modern plough improvements. The value of it on such lands, says the writer whom we have already quoted in this paragraph, is so obvious at sight that I claim no merit in having repeatedly recommended it in the West of England, the central Highlands, and other

places, for steep surfaces and absorbent subsoils. Even on level ground, whose subsoil is of an absorbent nature, this plough has its merits; and in breaking up whole ground to be cropped on one ploughing, as old sward, temporary ley, stubble, and especially where the soil is of a strong tenacious texture, it is a valuable instrument. The share being merely a socket, with a flatted point or chisel, without any fin or wing to separate the soil from its base, it is of course torn from it by strength of team, and in this violent operation the texture of the soil is broken so as to admit the tender fibrils of the succeeding crop. Add to this, the plit or plough-slice adhering strongly on the furrow-side, is turned with difficulty.

The Kentish turn-wrest plough, in spite of its ugly appearance, is considered by the best judges to be (when in the hands of skilful ploughmen) a most efficient implement; and I remember to have once heard the first plough-maker in England (and he lives at Bedford) say he considered Kent the best ploughed county in England.

The man who attempts to plough with this implement must thoroughly understand all its peculiarities, and be able to adjust it to the greatest nicety, for as it has to lay off both right and left, it must be perfectly true in all its bearings, and the coulter must set quite true to the furrow-edge it is cutting. What Marshall calls the nailing and tinkering on the part of its manager is caused by correcting any inclination the machine may have to swerve from a perfectly straight line, and which the complicated bracings necessary may cause it to do. The experienced ploughman, therefore, always carries in the foot of an old shoe, or a small leather bag, a quantity of nails of various sizes; these he fits in at the junction of the links with each other until the whole arrangement is to his mind. At ploughing-matches, it is no uncommon thing for the ploughman to fit in between twenty and thirty of these nails before he is

sufficiently satisfied with the general trim of his machine to commence operations.

Mr. Ransome observes that the work performed is excellent, and for deep and heavy ploughings, the principle is better adapted than a casual observer would suppose; but that it is not to be denied that it is a more cumbrous implement than a plough formed as a turn-wrest needs to be, for a large proportion of its present size and strength is requisite to provide against the strains to which it is subjected from the attempts to counterbalance the conflicting forces its erroneous construction has engendered. With a view to bring this plough into more general use, by getting rid of some of the least useful portions of it and remodelling of the others, a plough was constructed under the direction of Mr. William Smart, of Rainham, in Kent, and with such success that the improved plough might be made equally applicable to the power of two or four horses, according to the state or nature of the land on which it was to be used. In Vol. XIII., p. 59, of the "Farmers' Magazine" will be found a lengthened description of these improvements, and the views of the constructor in reference to the turn-wrest plough. Smart's plough is so constructed that the ploughman can shift the coulter as he pleases, and reverse the wrest from right to left without moving from his proper position between the stilts; this he effects by means of a lever through which the head of the coulter passes, and one end of which is brought conveniently up to a position just above the inner end of the plough-beam; and by a simple mechanical contrivance the turn-wrest can be removed from side to side, so that either becomes alternately the mould-board as the furrow requires to be turned. A screw-link and swivel is introduced in the chains to get rid of the nail business before mentioned. This plough in its improved form is manufactured by Messrs. Ransome, of Ipswich; the handles and beam are of wood, and the gallows of wrought iron.

There are a variety of other ploughs for effecting the same object as the one we have been describing, that is, the turning the furrows all in one direction, and laying the seams at an angle with the horizon. One of the first of these was invented by the late Mr. Smith, of Deanston; it was framed much like an ordinary iron Scotch plough, but had two mould-boards, one of which was elevated above the beam, while the other is at work. On arriving at the end of the furrow, the right and left handed mould-boards are reversed, by means of a handle fixed to the end of a spindle, placed longitudinally along the beam above the plough-frame; and on the end of this is placed an eccentric ingeniously contrived, by James Wilkie, of Addington, which, acting upon the coulter, sets it to the proper angle for the land side of the furrow, right or left, as may be. It obtained a premium from the Highland Society twenty years ago, and serves equally well for ploughing on the sides of the steepest hills as on the flat. In Mr. Ransome's book this plough is described as invented by James Smith, of Deanston. In other books it is called Wilkie's double mould-board turn-wrest plough. There was an implement in existence before this, exhibiting essentially the same principles, but was not nearly in so perfect a state. It was invented by Gray.

Hay's Turn-wrest.—This was the invention of Captain Hay, of Belton, and was peculiar: it had a right-handed body, and a left-handed one, placed end to end, its beam and stilts turning on a pivot at the centre of the top of the body, thus easily reversing, and turning the furrow right or left; its coulter is fixed to the beam in the ordinary manner.

Huckvale's Plough is thus described by Ransome. This plough is so constructed, that by reversing the position of one of its handles the ploughman is enabled to turn the body part from right to left, so that the part that was in one instance the slade or sole of the plough, will alternately become its land side, and thus act on either side of the plough;

that side which is not at work forming a close cover over the other. The share is formed with two blades or cutting edges at right angles, one of which acts horizontally as a share, and the other vertically as a coulter, and the position of which is changed at each end of the furrow by the same operation.

Read's Turn-wrest. — The improvement consists in the application of a pair of wheels, or a single wheel, as a roller, as circumstances may require. The leading wheel or wheels run on a plain surface of the land, and regulate the depth of the plough. The hind wheels are placed under the sole of the plough, commonly called the chep, and carry the hind part clear of the ground, by which means the great unnecessary friction arising from dragging the whole length along the furrow is greatly diminished. It is also applied to a mole-share, fitted to follow the hind wheels. This plough, with the mole-share acting 5 inches below the furrow, opens the pores, through a stratum of earth that has been trodden for the last century (by driving horses in the furrow), until it became nearly as impervious as a sheet of lead. It has, with the mole-share attached, been drawn by four horses for a whole day, ridging up wheat upon very stiff lands. Where land has been drained ridging is unnecessary; the surface of the field may be left plain, without furrows. To accomplish this, the ground-wrest is taken off at the end of every furrow, and shifted to the other side, while the horses are turning, and the coulter shifted by means of a lever at the top of the beam. The snap-wrest is not taken off to turn the furrow, but passes through the body of the plough; the lever shifts the coulter the same as the turn-wrest.

LOWCOCK'S PATENT PLOUGH.

This plough is for the purpose of turning furrows in one line of direction, and parallel to each other. It is almost

self-acting, as respects its adaptation to each succeeding furrow; and so simple in its formation that any ploughman may at once use it to advantage.

It will be seen upon inspection that the plough does not require to be turned round at the end of the field; but the ploughman having completed his furrow, to the right, passing on the furrow side of the plough, turns over the handles from one end of the beam to the other, when they are re-adjusted by a catch affixed to them, which, dropping into a mortice at the beam-head, renders them stationary. Whilst performing this simple operation, the horses turn round on the land side of the plough (thus preventing the ploughed land from being trodden), and by the act of turning, the draught-chain to which they are attached slides on a rod to the other end of the plough. As soon as the horses commence drawing, the left-hand share and coulter set into their work; the double fly, which forms a part of the mould-board each way, coming in contact with the newly-cut furrow, instantly turns back and assumes its correct position, and the implement proceeds without further adjustment, cutting out and turning over the furrow-slice to the left hand. The utility of a plough of this description is obvious, whether for ley crops, in small, irregular, and hilly fields, or in lands that will not bear treading when wet.

CLARK'S UNIVERSAL RIDGE PLOUGH.

Is the invention of John Clark, of Long Sutton Marsh, to whom a medal was awarded by the Royal Agricultural Society of England.

It is adapted to the several purposes of ridge culture, and by an easy transition of shape, which is accomplished in a simple manner, it becomes,

1st. A double tom or ridge plough, for opening or closing the soil, as in ridge-ploughing, or for setting out the land for

ordinary ploughing, or for opening the surface-drains in water-furrows, &c.

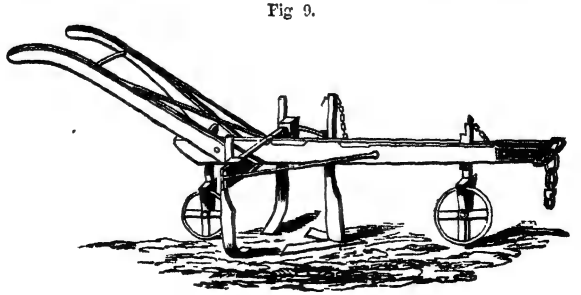
2nd. A moulding plough for moulding up roots, crops, and other purposes.

3rd. It may be converted into a horse-hoe or cleaning plough, with curved coulters, for cleaning the sides of ridges, or with flat hoes for broad work; or it may, with slight modification, become a broad-share plough, to which rising prongs or shares may be attached, for the purpose of clearing land from weeds and rubbish. This implement is exceeding well adapted to small holders who cannot afford to have a great variety of implements lying idle for a large portion of their time. Machines and implements of all kinds, whether mills, ploughs, &c., that are adapted to execute a variety of different operations, are deserving of special encouragement, as being so particularly adapted to the wants of the small farmer, who, without them, is working at great disadvantage with his neighbours, whose operations are on a much larger extent of ground.

RANSOME'S HOE PLOUGH.

Is for the purpose of hoeing up weeds, and stirring and loosening the soil between the rows of plants. It has two wheels, one in front, and one behind the hoes, by which the

Fig 9.



depth of hoeing is regulated. It may be used with three triangular hoes, each cutting 13½ inches wide, extending over 3 feet 6 inches, or contracted to a smaller width; or the two hind hoes may be substituted by two curved knives, as shown in fig. 9, for cutting the weeds up on the sides of ridges. It is a very simple implement, capable of doing a great deal of work, and may be adapted to a variety of purposes.

MOULDING PLOUGHS, OR DOUBLE TOMS.

These are made with two mould-boards, one on either side, and are used for earthing up plants sown upon the ridge; the mould is turned up lightly on the right and left sides, as the plough passes along between the rows. It is also frequently used for opening water-furrows between the breadths of ploughed land. When the mould-boards are removed, it may be applied as a broad-share plough for cleaning land, or as a light description of subsoil. They are manufactured by Messrs. Ransome of an improved form, and may be adapted to a variety of useful purposes, with the addition of some very simple parts.

THE DOUBLE FURROW PLOUGH.

Is an implement of such ancient date that it is mentioned by Walter Blythe, who wrote during the protectorate of Oliver Cromwell; but was not extensively brought into use until it was recommended by some improvements of the late Lord Somerville, whom many persons have viewed as its original inventor. The late Mr. Billingsley, of Shepton Mallet, says that some may doubt the possibility of making the double plough so generally useful; but he can truly say that he never yet found an instance where it could not be worked to advantage; and it is well known that, in the various trials made under the

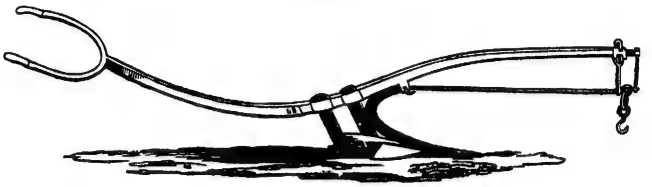
auspices of the Bath Society, on lands of the most difficult nature, the double plough has always gained the prize. It has been recommended by judges, when drawn by four horses, and put in competition with a Norfolk wheel plough, a light Carlisle swing plough, and a common Wiltshire plough, each drawn by a pair, "as the best and cheapest for general use;" the decision also stating "that the double coulter plough had been preferred for the general purposes of husbandry, laying the furrow more flat than the others, and consequently exposing more new surface to the influence of the elements, and preventing more completely the growth of grass and weeds between the furrows." Although on light soils it may be used with considerable profit, if the ground be tolerably level, yet if the surface be very uneven, it works to disadvantage; nor can it be properly worked on land that has not been previously broken up, and it can be of very little use where it is the custom to raise the crown of the ridge considerably above the furrow, since it cannot perform the operations of "gathering or cleaning." Double furrow ploughs of an improved form are manufactured by Ransome and May, of Ipswich.

SUBSOIL PLOUGHS.

The practice of subsoiling has been productive of perhaps greater immediate benefits to the farmer than almost any improvement that has been introduced of late years, for subsoil ploughing is the breaking up the stratum of earth immediately under that which is annually ploughed and prepared for the growing of crops, and upon which the horses have, ever since the ground was first cultivated with a plough, been walking, so treading it into an impermeable mass, through which the water cannot pass but with difficulty, or the roots of the plants force their way. If subsoiling be well done it will generally repay its cost the

first year, as the soil broken up has through time been receiving much of the fertilising matter laid on above, and a heavy crop is sure to be the reward for the expense incurred; but I would advise all persons about to subsoil

Fig 10



land, especially if there be a pan or crust to break up, to employ some person whom they can trust (the farmer himself ought to do it) to walk beside the plough the whole time the operation is going on, and continually with a spade examine the soil, and see if it be effectually broken up. Unless this be done, I am sure the work will not be properly executed. I have tried all sorts of men at the subsoil plough, and never knew an instance where the ordinary ploughman would keep the plough down, if he could avoid it; in nine cases out of ten he believes the whole operation to be a new-fangled idea from which no benefit will be derived, and if his horses are good, and he takes much pride in their sleek condition, he will certainly sacrifice the efficiency of the operation for the benefit of his favourite animals. The master must never leave the plough, and must always insist that the depth decided on be kept, never minding how much the man complains of himself and his horses, and always remembering that it is better to do a small piece thoroughly well, than to run lightly over the whole farm. Subsoil ploughs have been used and appreciated for many years; the first mention made of one is in "Worlidge's Mysteries of Husbandry," 1677. He tells of an ingenious

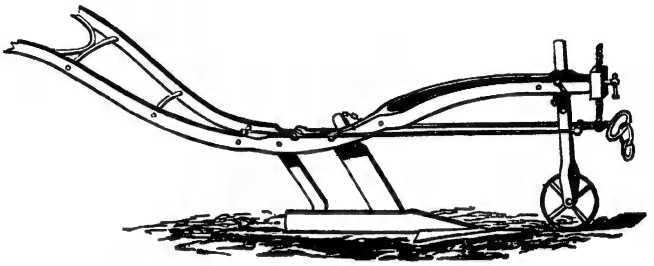
young man in Kent who had two ploughs fastened very firmly together, by the which he ploughed two furrows at once, one under the other, and so stirred up the land 12 to 14 inches deep. This is clearly a regular subsoil operation; but no such practice became general, until James Smith, of Deanston, had invented a proper plough for the purpose, and pursued subsoiling as a regular tillage operation. His plough is by far the best known and appreciated of any of the deep working ploughs. Fig. 10 represents this implement; it has no mould-board nor land side-plates, and is in fact only a skeleton plough of great strength.

A longitudinal feather stands in the place of a mould-board; it has a strong pointed share, with a flat feather; it has also a curved and self-cleaning coulter. The draught is applied through a bridle and chain bar. Mr. Smith says it is intended merely to break up and stir the subsoil, without bringing it to the surface, or mixing it in the first instance with the superincumbent soil; it is in fact a horse pick, and readily loosens and throws out all stones, not exceeding 70 lb. in weight. It is drawn by four horses, two and two abreast, and is held in the usual way by one man. In working, the common plough goes before it, taking a furrow 10 inches by 6 inches, the subsoil implement following in the bottom of that furrow, and going deeper by 10 or 12 inches.

THE RACKHEATH SUBSOIL PLOUGH.

This is the invention of Sir E. Stracey. It is of a lighter description than the Deanston plough, and effects its object

Fig 11.



in a satisfactory manner. When fitted with wheels it makes a most valuable subturf plough, and is useful in a variety of ways.

THE CHARLBURY SUBSOIL PLOUGH

Is the invention of Philip Pusey, Esq., M.P., and is intended as a substitute for the Deanston plough. Mr. Pusey's improvements are described by him in an interesting paper in the *Journal of the Royal Agricultural Society*, vol. I. p. 433. He says, "It struck me, therefore, that possibly the discovery of Mr. Smith might be carried a little farther, and be brought more within ordinary means, if we could diminish the friction necessarily incurred in passing through the unstirred subsoil by dispensing with more parts of the common plough besides the mould-board; and I determined to try whether, by combining in one plough the two hitherto used, we might not get rid of the sole itself in the underground implement, trusting to the ordinary sole above ground for preserving the balance, and so reducing the instrument below the furrow (where the

friction and resistance are, of course, very great), to a mere cutting or stirring-tool.

The experimental plough was constructed by Hart, of Wantage, by placing a strong iron socket behind one of his own single-wheel ploughs, constructed with greater strength in the beam than usual; into this socket a tine, similar to those of Biddle's scarifier, but thinner, was placed. This back tine could be raised or lowered at pleasure. It was placed on the off-side of the beam, in order that it might work in the middle of the fresh furrow, and so act more freely than if it was placed on the near-side, immediately against the unstirred land.

A trial of the draught of this plough was made with Mr. Cottam's draught gauge, and found to be between 7 and 8 cwt.; while the draught of the Deanston subsoil was 12 cwt., and adding to which 2 cwt. for the plough that first opens the furrow, the labour of the horses would be equal to 14 cwt. altogether. Mr. Pusey states that the subsoil was more thoroughly stirred by the Deanston implement; but that one of the principal objects of subsoiling—the letting the water down to the drains through clefts left in the subsoil—was accomplished equally with his plough as the the heavier one.

BARRETT, EXALL, AND ANDREWS'S SUBSOIL PLOUGH.

The mechanical construction of this plough is simple, and in practice it is found to work lighter than the single-share plough. It is constructed with two or three tines or shares, so adjusted in position, and formed of such shape, as would most easily overcome resistance; each share, preceding its follower, lessens its work by breaking up the upper crust of the soil, and the lower share can either be shaped as an O or ⏀, so leaving an arched drain to carry away the top water to the main drains.

READ'S SUBPULVERISER.

This is a very useful and efficient implement, and should be in constant use on every farm, for it is one of the best subsoil ploughs ever made.

At the meeting of the Royal Agricultural Society at Southampton, this plough was put to the test by the judges, with several others, in the hard-baked soil of Mr. Spooner's farm. The pan, or old plough-floor, of this field had evidently never been invaded by agricultural tools. Below six inches it was as solid as continual trampling can be conceived to have made a tenacious loam, aided by a drought of several weeks' duration. Mr. Read's pulveriser was put into the furrow opened by a plough, and set to work at about six inches under it. To use the judges' own words, "the old floor was split into fragments like broken tiles, and the soil separated and pulverised."—*Royal Agricultural Society's Journal*, vol. V., Part 2, p. 371.

I have used this plough much myself in breaking up moor-pan, and can confidently recommend it as a generally useful implement. It may be adapted to a variety of purposes by substituting different formed shares and tines, and used as a turf-plough, grubber, horse-hoe, &c., &c. It is sometimes made with wooden beams and stilts, and at others with Stratten's patent hollow-iron beam. In the latter form it is much stronger and more durable.

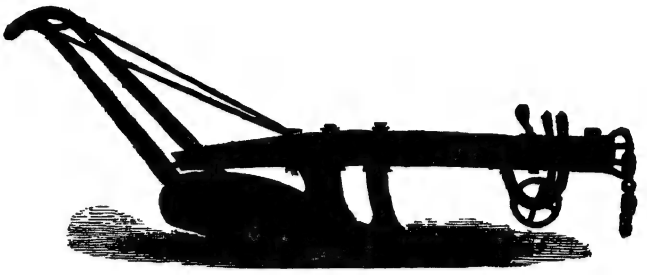
AN AMERICAN PLOUGH.

This is a representation of one of the American ploughs exhibited at the Great Exhibition of all Nations, and which excited great interest among agriculturists who saw them.

They are said to possess peculiar advantages in the locality of the lands they are intended to break up; but they are not

available here in any way that I am aware of, though I observe one house advertises to supply English farmers with these

Fig. 12.



remarkable implements. I doubt much whether any one who has seen the ploughs of our best makers will ever be persuaded to buy them, so utterly different are they to all those notions which we are agreed about in reference to ploughs.

Some very ingenious implements were exhibited nevertheless—one, in particular, which was so constructed that the mould-board turned underneath and adapted itself equally well to one side or the other; and, among others, one which has chisel-headed shares, which could be protruded forward as it wore away, being thus always self-sharpening. This principle might be applied with advantage to ploughs intended for the colonies.

PLOUGHING BY STEAM

Has not yet been brought to such a state as to be applicable to ordinary practice. A number of gentlemen have, at different times, brought forward plans for ploughing by steam, and, much to their honour, have given the different methods a fair trial without regard to the expense; and so far as the mere fact of the practicability of ploughing by

steam is concerned, it has been accomplished—whole fields having been well ploughed, in a number of different trials conducted by Mr. Heathcote and other gentlemen.

Some of the most recent of these have been made by Lord Willoughby d'Eresby, at Grimsthorpe, and with great success. In this case a portable engine works down the centre of the field upon a sort of portable railway; the ploughs work backwards and forwards between it and the side of the field, drawn by chains and windlasses worked by the engine.

At a recent meeting of the Royal Institution, the Duke of Northumberland in the chair—J. Wilson, Esq., on Ploughs and Ploughing, ancient and modern. Mr. Wilson, after a general history of ploughs, summed up as follows:—

"Let us see what would be the result of the substitution of the steam plough for our present systems of ploughing. In England, taking Caird's estimate, there are 14,000,000 acres in tillage; these are ploughed certainly once every year. The cost of the operation averages at least 10*s.* per acre, thus giving a total of 7,000,000*l.* per annum. This first machine of Usher does the work better than by the plough for 2*s.* 6*d.* per acre, or at 75 per cent. less cost. The saving would consequently be about 5,250,000*l.* per annum. The labour of 50,000 men, and 100,000 horses, required for this one operation, would be replaced, and a saving in the consumption of corn effected to at least 1,500,000 quarters, which would be thus rendered available for the more direct wants of the community."

CHAPTER III.

HARROWS AND CULTIVATORS.

THE next operation after the plough is that of harrowing. It requires to be performed at different times on all descriptions of land, for pulverising and reducing the clods of stiff land, and extracting couch, &c., upon light. It is required for preparing the land for sowing, and is used for covering the seed with the earth after the crop has been sown.

This implement is of equal antiquity with the plough, for an instrument of this kind must have existed in some shape or other from the earliest periods in the history of agriculture; for as the opening up of the soil required the aid of the plough, so did the covering up the seed the assistance of another implement of entirely different character. A branch of a tree was doubtless the first instrument used for the purpose, and in the early operation upon the soil, little more would be required than such an implement would perform; indeed, so lately as 1668, an agricultural writer gives directions for constructing a harrow, thus:—"Get a pretty big white-thorn tree, and make sure that it be wonderful thick, bushy, and rough-grown." In many parts of the world, at the present time, no better harrow exists. In Norway, Russia, and other countries where fir-trees abound, the harrows are generally constructed by fastening several lengths of tree side by side, with a cross-piece on the top to hold them together. As they are drawn along, the projecting spurs act as tines, and the trees roll about as they are drawn forward, and effect the operation of harrowing in a much better manner than might be supposed. A similar imple-

ment, of a lighter kind, is also constructed by fastening the fir-logs across the opposite way. The Belgian Hacken is formed of thick spars of wood fastened together, but it has no teeth. A framework of wood and wooden teeth may be found in some remote farms in England at the present time; the introduction of iron teeth is comparatively a modern improvement.

The harrow performs its work by means of the teeth, or tines, as they are called, pressed into the soil by their own weight and that of the frame to which they are attached. They are made of a variety of shapes and weights, according to the description of land on which they are to be employed. The heaviest kind are called drags; and the smaller, harrows. The drags are used singly, or two coupled together; the light harrows are worked in gangs.

The drags are constructed with tines from nine inches to a foot in length, and are securely fastened to a wooden framework composed of cross bars, the strongest of which are called the balks or bulls, and are placed lengthways in the frame.

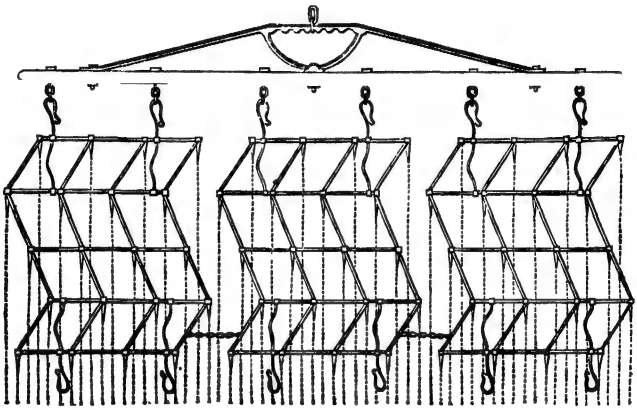
The tines are sometimes made like plough coulters, and rake considerably forward. A pair of wheels have also been fitted to them, and an arrangement made to adjust the depth of the tines; but when thus treated the implement approaches nearly to the grubber and scarifier (which will be found described under their respective heads), and many of the operations formerly performed by drags are now done in a much more efficient manner by some descriptions of the latter implements.

Small harrows are always worked connected together, or in gangs, attached to each other in a variety of ways by links, so as to allow them sufficient play to yield to the curved form of the ridges, and thus perform the work very completely.

Howards, of Bedford, are celebrated for the manufacture

of harrows of all kinds, more particularly those on the principle invented by W. Armstrong, and shown in fig. 13.

Fig. 13.



In these harrows the teeth are so arranged that each cuts a separate track, at equal distances; the draught is from a centre, so that any irregular pace of the horses does not affect them by drawing them out of their proper track. The balks are of zig-zag form, which allows of the tines working in lines very close to each other, yet preventing any inclination to clog.

Each harrow is attached to the whippletree by double hooks, which prevent them, in rough work and turning, from riding upon each other, and also, when working upon the side of a hill, from inclining towards the lower ground. They are furnished with hooks at the hinder part, in order to draw them the contrary way when harrowing-in seed or crops in the spring; by this means the soil is not rooted up or penetrated so deep as when drawn forward in the usual manner.

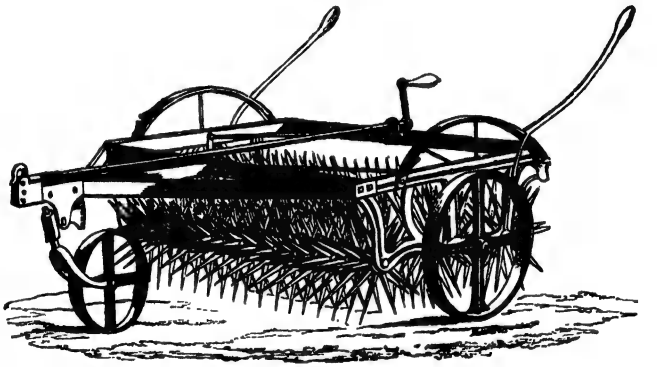
The teeth are made with a square shoulder, and secured to the frame by means of screws and nuts; consequently they

may be taken out and re-laid without injuring the frame or beams. Each tooth is secured with a double nut, to prevent its shaking loose.

THE NORWEGIAN HARROW.

This implement is becoming a great favourite with agriculturists, and deservedly so, for it far surpasses the ordinary harrows (of whatever kind) in performing several important

Fig 14.



operations: first, for harrowing immediately after ploughing, it breaks and pulverises the furrow, leaving 3 or 4 inches' depth of fine mould beautifully prepared for seed; it saves the use of heavy and middle-sized ordinary harrows, the small seed harrows once over after sowing being sufficient. Secondly, while other pulverisers consolidate the land, and harrows leave the clay in large lumps, this implement pulverises, but does not consolidate. Thirdly, it prepares the roughest land, whether wet or dry, without clogging.

Fig. 14 represents this machine, as manufactured by Crosskill, of Beverley. It has three sets of rowels, 4 feet 6 inches wide, placed upon round axles.

An improved method of regulating has also been adopted, to adjust the true incline of the harrow spikelets or rowels, which very much reduces the draught.

Making the points longer, oval-shaped, and thinner, has been found to materially improve this implement, as it enables them to cut, and get more hold of tough and hard soil, as well as to work the land deeper.

CULTIVATORS.

Under this head may be placed a large class of implements, bearing a variety of names, as drags, scarifiers, grubbers, scufflers, pulverisers, &c., &c., but whose objects all tend to the same purpose, that is the producing a fine tilth to the soil, tearing up the surface, and eradicating the weeds and rubbish. Harrows might very properly be placed in the same category, as the object of their use is precisely the same, the difference being only in the size and effectiveness of the machine; harrows being fitted with a large number of small teeth, and acting comparatively on the surface, while the implements we have placed under the head of cultivators have a few teeth, but of much greater strength and size, consequently their operations extend to a greater depth into the ground, and a variety of operations are performed by their aid that could not be accomplished by harrows; indeed, so strong and effective are some of the larger kind, that they are used in some cases instead of ploughs; and stubbles, &c., are often broken up, and the land re-sown, without the plough being used.

Although the use of such implements is of a modern date, yet cultivators have been in use in some shape or other for a considerable period. I find, in a book published more than fifty years since, several descriptions of instruments bearing characteristics much like those now in use, and high eulogiums passed upon their use. One of them

much resembles the implement lately introduced as Johnson's Cultivator, and which will be found described at page 66. It is called a broad-share skim, and used for the purpose of cleaning stubbles, particularly beans, peas, &c., to prepare them for spring crops.

"In the Isle of Thanet these are made straight and sharp, very strong, 4 feet in length, and are often hung behind a pair of cart-wheels. Elsewhere they are made in the form of a crescent, or of a large prong with three or four large flat tines drawn horizontally, with the points forward, which force their way among the flints and loose stones." *Hayward's Extirpator* is also described as a most powerful implement, and a plate of it is given in Young's "Suffolk." The tines and shares are fixed in an oblong wooden frame. The shares 8 inches broad and 9 inches long, fixed to stalks rising 10 inches, the distance between them being 11 inches, the hind ledge 6 feet long and 4 inches square, the fore-ledge 5½ feet long and 4 inches square, the ledges 12 inches apart, the beam 7 feet long, its elevation 3 feet 3 inches. It was fitted with two handles, and fixed to the wheels of a common plough, and made to go shallow or deep in the same manner.

This implement is much like one introduced many years later by Fuller of Ipswich, with the difference that Fuller's had but one row of tines, and the ledges which carried them were supported on wheels; but this latter implement was quickly superseded by an ingenious machine, called Finlayson's patent Self-cleaning Harrow, a well-known implement, upon the principle of which a variety of similar machines have been constructed of modified forms. Among these Wilkie's Parallel Adjusting Brake may be mentioned, as having some important improvements, yet constructed upon precisely the same plan.

KIRKWOOD'S GRUBBER

Was also of a similar character, but had the important addition of handles, which gave the operator power to regulate the depth to the greatest nicety, and when it became chocked to throw it out of work.

BIDDELL'S SCARIFIER

Approaches more nearly to this class of implements as now constructed. It consists of a double row of tines of great strength, fixed in an iron frame which is supported by two wheels about 4 feet in height; the teeth are so arranged that those in the hinder row shall work in a track midway between that of the front ones; the fore-end of the machine is supported on two smaller wheels attached to an upright shaft, the machine thus being suspended upon three pivots; and by means of two ingeniously arranged levers the two rows of tines may be made to work in any manner that may be required. It is altogether a most admirable machine, and capable of executing a large amount of work in a short time, and under difficult circumstances; but it has now given way to another, of a somewhat different character, called

LORD DUCIE'S CULTIVATOR, OR THE DUCIE DRAG.

This implement is now very generally used, and is manufactured by most machinists, and although its actual form and manner of getting up may vary occasionally, according to the ingenuity or fancy of the maker, its principles always remain the same. The Ducie Drag, or

The Uley Cultivator, as it is often called, rests upon four wheels, the front ones being 1 foot 6 inches, and the hind ones 3 feet 4 inches in diameter. It is constructed of iron, of a strong and compact form.

The teeth are not placed in rows, but are arranged 2 feet apart, while the difference of the working track is only 6 inches. It is raised out of the ground, and the depth of working regulated with the greatest ease, by turning a handle upon which a worm is fixed, working into a wheel fixed on the cranked axle. This efficient implement is manufactured by Barrett and Exall, of Reading, of an improved form. The tines are so curved as to assist the action, by causing the rubbish to be deposited upon the top of the land; the points and shares are made to fit on without being pinned. An excellent variety of this implement was made by Stratton, of Bristol, with the application of his hollow iron bar. Having had considerable experience with this particular form of drag, I can confidently recommend it for the many purposes to which such implements are put.

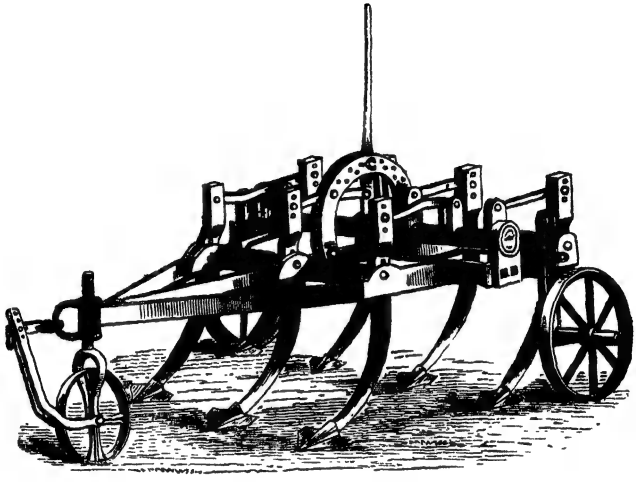
COLMAN'S DRAG HARROW CULTIVATOR, OR SCARIFIER.

This is an excellent implement, invented by Colman, of Chelmsford, and manufactured by Garrett and others.

It is constructed upon a novel principle, and is well adapted for harrowing, paring, and cultivating land. There are seven prongs or tines, to which shares or spuds, varying from 2 to 10 inches wide, may be affixed. These prongs are arranged so as to cut the land 8 inches apart; the depth of penetration being regulated by a lever which acts upon a frame suspended about 6 inches above the lower one, and by an easy movement backwards or forwards regulates the depth of the tines or shares to the greatest nicety. It is a most efficient implement for opening and pulverising the soil; as shares of different forms may be placed upon the tines, it may easily be applied to other purposes, as a skim-parer, &c. Messrs. Garrett have added an improvement, by which one side may be depressed lower than the other, to

adapt it better for working on sloping ground, and so simply that it can be altered while in use.

Fig 15

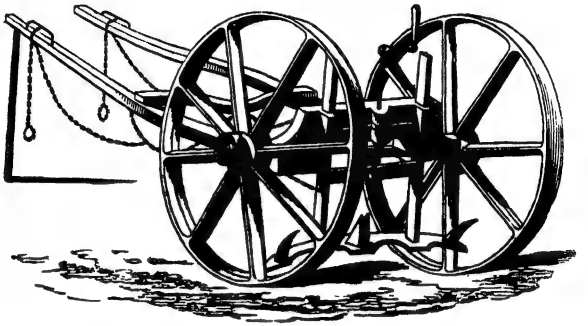


A smaller implement, called a subsoil harrow, is also manufactured by Colman, for stirring the subsoil; it has two tines, united by the framework above, and a connecting-bar at the bottom, upon the end of which is placed a kind of share, the depth being regulated by a lever similar to the large drag.

JOHNSON'S SKIM CULTIVATOR.

This is the invention of the Rev. E. H. Johnson, of Grovelye, Linfield, Sussex, and is manufactured by Messrs. Garrett. It is for the purpose of breaking up and pulverising land, clearing it of weeds, rubbish, and of couch grass, and it is asserted, at a less expense than by the means usually resorted to. It is said that a lad with three horses may go over five acres per day; and as the implement, from its simple form,

is not so likely to choke up as most similar implements are, or require to be taken out of the ground so often, it is quite possible this may be the case. It is found greatly to facili-



tate the working of land during, and immediately after, harvest, for the purpose of bringing it into a proper state of tilth for the early root-crops in the spring of the year, and also for cleaning bean and pea stubbles, tare lands, &c., in preparation for coleworts, mustard, rape, and turnips, for early autumn feeding, and leave the land in a good state for the wheat crop.

ROLLERS.

The operation of rolling land is to effect several different objects, the principal of which are, the breaking the large lumps of earth that have been sun-dried, and to assist in the preparation of a finer tilth, or pressing in the ground about newly-sown seed, and to compress and smooth the surface of grass land, and render it better adapted for mowing. The roller is a modern implement, as it would not be required in the cultivation of such lands as were cropped in earlier times.

Rollers are made of wood, stone, and iron. The old implement was a rude affair, constructed on the farm with the best materials that could be had. Stone was introduced as being more effective from its greater weight, but could not be made of the same width, and therefore was more inconvenient. Iron is now the material generally employed, and it is by far the best.

An immense number of differently designed rollers have been introduced—one of the earliest was by Mr. Booth, of Allerton, near Liverpool, and is described by Mr. Ransome as consisting of five cylinders of small diameters, pressed into the ground by levers with weights attached. The inventor considered that rollers with small diameters would act much more effectively than those that were larger; this, however, was an erroneous opinion, as the advantage gained by its acting on a smaller space was more than counterbalanced by the difficulty of getting it to travel over rough land.

The modern iron roller is a very effective implement. It is generally constructed of two or more separate cylinders of various diameters, the axis of each being independent of the other—thus enabling it to turn with facility, and without injuring the crops, whether grass or grain. One, made 6 feet 6 inches long, and 20 inches diameter, weighs about 9 cwt. The barley-roller consists of two cylinders, one a little in advance of the other, but in a parallel line. The two inner ends cross an inch, so as to leave no land unrolled, and being jointed by a hook and eye rather loosely, the roller adapts itself to an uneven surface. Each roller is 5 feet long and 10 inches diameter.

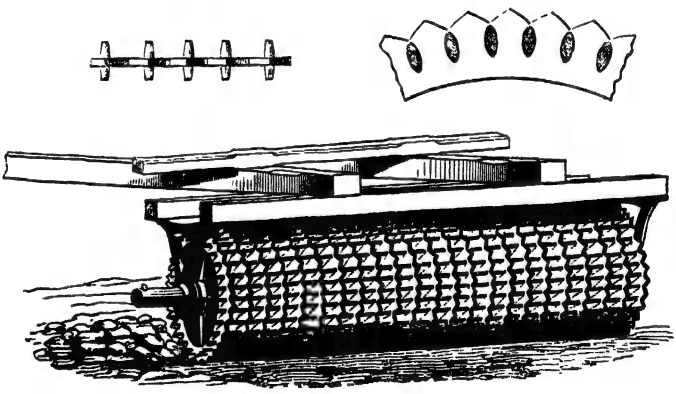
The Northumbrian Roller consists of two series of iron rings, or discs, running loosely on axles; the wheels, or discs, of one row locking into the other row in front, each disc of the hinder row thus running between two on the first row. The edges being sharp, similar to Cambridge's

roller, it acts well as a clod-crusher. It is manufactured by Gibson and Son, of Newcastle. Wheels of larger diameter are attached to gudgeons, fixed at either end of the machine, to facilitate its removal from place to place, similar to those described as attached to the Crosskill clod-crusher.

CROSSKILL'S CLOD-CRUSHER.

Of all the modern implements introduced, this may be pronounced the most valuable and most generally appreciated, and the most useful for effecting a variety of different mechanical operations, and in giving a fine tilth to the soil.

Fig 17.



Crosskill's roller, as now manufactured, is the result of great experience in its use, a variety of improvements having been made in it since it was first patented. It has always been brought to compete with rollers of similar character, and always carried away the prize—no other implement of its kind ever having stood the least chance when in competition with it.

This implement is successfully applied to effect the three different purposes for which the spike-roller, the Norwegian, and the wheel-roller are employed, and effects the object better than these three combined. The advantages gained by the use of this implement are—first, the lessening the expenses of tillage by mechanical aid, in crushing the hardest clods, and pulverising the roughest fallow land; secondly, in compressing light and puffy soil to grow therefrom stronger and more productive plants; thirdly, in rolling cultivated land, and preventing the ravages of the wire-worm and grub, thereby increasing the quantity and improving the quality of the corn. The machine consists of a series of cast-metal rings, or roller-parts, placed loosely upon a round axle, and revolving thereon independently of each other, thereby producing a self-cleaning action, and by which the machine is turned round about on fields of growing corn without tearing up the soil, destroying the plants, or half burying itself in a hole while turning, as many similar implements do. The surfaces of the roller-parts are pointed with serrated edges and a series of inner teeth, projecting sideways, fixed at a particular angle to the centre of the roller-axle, so as to act most effectually in penetrating clods perpendicularly, and in consolidating the young plants in the soil. The discs on this roller (as originally constructed) were fast upon the axle, but they are now made to revolve independently of each other, an advantage which not only increases its efficiency, but materially lessens the power required for its draught. Another improvement has also been made in making the eye larger in the hold, so that when revolving separately upon the round axle, they cause an irregular velocity by the rims perpetually varying, and effecting an eccentric, or up and down, action along the whole of the roller parts, thereby increasing its power, and giving it the best means for self-cleaning itself in working.

As this roller could not be removed from place to place as

an ordinary one, two travelling wheels are added of larger diameter, so as to lift the roller-parts clear off the ground. When the roller has arrived in the field where it is intended to be used, a hole has to be dug under each of these travelling wheels deep enough to let the roller-part down upon the ground. The same operation has to be repeated when the wheels are to be again placed upon the shaft.

This machine is now manufactured of a variety of sizes, adapted to the various kinds of plants and systems of husbandry. The following are some of the advantages and effects produced by the use of this machine, and a few of the purposes to which it may be applied:—For crushing the hardest clods in the driest seasons upon the strongest fallow lands, the deep indented edge-points of this ponderous machine penetrate and abrade the roughest clods, reducing big masses of clay and baked soil into a fine mould, where, in many cases, from the nature of the soil, and the inefficiency of other implements, it would be difficult, or even impossible, to prepare the land without the serrated clod-crusher. It insures the certainty of a sowing season in the driest weather, and rapidly converts many acres of heavy land into the finest condition for the reception of grain or the smallest seeds, and leaves the soil then equal to once harrowing. Spike rollers and Norwegian harrows will not effect this, as they drive the large sun-dried clods before them, or pass harmlessly over the surface. It is also valuable on strong land farms to prepare the ground before drilling, and again rolling over it as soon as sown. Upon lands sown in autumn, which are cloddy in the spring, it reduces these, and gives a fine surface-mould, while it prepares the soil around the roots of the young plants, without in the slightest degree injuring them. Upon light soils it is preferred to the action of seam-pressers, as it effects the desired degree of tenacity and solidity without leaving a smooth surface, and entirely prevents the land from scarping, which frequently occurs after using a plain roller.

The practice of driving sheep over corn-lands to give firmness to or fasten the soil, is rendered unnecessary by using this machine, as the action of the tread of the sheep is well imitated by it, and it effects the object in a more equal manner. The serrated teeth (when the land is very light) go down to the roots, and firmly secure the young plants in the soil, leaving little hillocks, or a harrowed-like surface which affords a beautiful protection against cutting winds and intense frost.

Oats, wheat, and barley may be rolled and much improved at a cost of 2*s.* per acre. The action of this roller has been well compared to the act of a gardener pressing the mould with his fingers round the young plants, while the common smooth roller more resembles the act of putting one's foot upon the plant, which would be likely to destroy it.

It is also used for preparing land to sow clover, beet, &c. It makes the finest bed for the reception of the smallest fine seeds.

For staying the ravages of the wireworm, this implement is of the greatest possible advantage. I have myself used it for the purpose with the greatest success. I have rolled one part of a field that was full of wireworm, and left the other. The half rolled carried a good crop, while that which had been left to itself was utterly destroyed.

In the *Royal Agricultural Society's Journal*, vol. IV., part ii., pp. 560 to 580, will be found a report upon all these various advantages said to be obtained from the use of this roller, and the replies of an immense number of leading agriculturists to the following queries:—

1. How far valuable for crushing clods, and breaking up the strongest fallows in the driest seasons?
2. How far valuable upon strong lands, for rolling corn as soon as sown, and lands sown late in the year, which are cloddy in the spring?

3. How far valuable upon light lands, for rolling corn as soon as sown, and in the spring, after frost?
4. How far valuable in stopping the ravages of the wire-worm and grub?
5. How far valuable upon grass lands, upon mossy lands, and worm in meadow lands?

To all these queries the most satisfactory answers were given, showing that for all the different objects enumerated in the queries, this machine was specially valuable, and in none more so than in stopping the ravages of the wireworm.

An immense number of these replies are printed in the journal alluded to, and many contain valuable remarks and hints well worth attentive perusal.

Some people have adopted the plan of rolling between the rows of potatoes, beans, &c. (growing crops); it is said to do what could not otherwise be effected, that is, leaving a crushed, pressed, and harrowed-like surface between the rows, even when the potatoes are grown several inches. The 6 feet size of roller is best adapted for this purpose, as it will roll three rows at a time. The horse walks in a line up the centre row, and the iron discs being removed from the axle where the lines of plants occur, and in their places iron bushes placed, so dividing the great roller into three smaller ones.

A serrated roller of a much lighter description has been constructed for fen lands.

It has been remarked that the roller requires much judgment in choosing the fitting time to use it, and this observation applies more especially to the one we have been describing.

CAMBRIDGE'S PRESS WHEEL ROLLER.

This also is a clod-crusher of an efficient character. It is composed of a number of wheels or discs of iron placed side by side, with thin cutting edges. It is considered a useful implement, and acts well in crushing clods and preventing the ravages of wireworms and slugs, and in rolling pastures.

A great variety of other rollers are manufactured, and called by a variety of distinguishing names, as drill rollers, seam or land pressers, &c., the peculiarities of which we have not space in this little book to describe.

THE HORSE-HOE.

To Jethro Tull (the introducer of the drill system of husbandry into England) we are indebted for this most valuable implement, he being its original inventor; for, as Mr. Ransome remarks (in his "Implements of Husbandry"), "previous to his time we search in vain for the slightest allusion to such an instrument in the works of any writer upon agricultural subjects."

Tull laid the foundation of the present advanced state of agricultural science, in the adoption of what he called horse-hoeing husbandry; indeed, so much was he in advance of his time, that it is only now that his works are being properly studied and understood; for although, like most enthusiasts, he carried his principles too far, yet in the main he was right, and the drill and horse-hoe are the two implements upon which depend much of the farmer's success in the cultivating crops with profit.

The horse-hoe possesses immense advantages over hand-hoeing, principally in the rapidity of the operation, and in the economy of labour; for, as Mr. Blackie remarks,

"expedition is a most material point in all processes of husbandry carried on in a variable and uncertain climate; and it frequently happens that hoeing in any way can only be executed to advantage in a very few days in the spring; hence the horse-hoe has a most decided advantage over the hand-hoe, for a man will only hoe about half-an-acre a day with the latter, while with the former a man and a boy, with one horse, will hoe eight or ten acres a day, and that in a more effectual manner."

Tull's horse-hoe, as he originally contrived it, is represented in his book. It is a rude implement, somewhat resembling a roughly-shaped swing-plough, without a mould-board, and having the cutting edge of the share turned up on the land side.

Subsequent horse-hoes, while less rude and more ingeniously contrived, were all of a simple character, and generally resembled swing ploughs fitted with hoes, or were a description of implement more resembling modern grubbers or scufflers. One of these bore the name of the Kentish nidget, or tormentor, and is described as a horse-hoe with triangular shares fixed horizontally at the extremities of tines, which are driven into a three-cornered wooden frame in cross-bars. At the corner by which the implement is drawn, a wheel is fixed, in order to give the coulters their proper depth. The shim or broad-share was another description of implement of the horse-hoe character, as was also an implement called Hayward's extirpator.

A hoe was invented by the elder Wilkie, of Teddingstone, about the year 1818, and considered a very efficient implement. Three coulters were attached to the body and wings of the beam of a plough; a small harrow followed, and a wheel was placed at the end of the beam to regulate the depth, and facilitate the turning it and clearing it of weeds.

A horse-hoe with parallel motion was invented by the

younger Wilkie, which admitted of easy expansion and contraction, to suit the different widths of drills.

Weir's expanding horse-hoe was of a similar character, and might be worked either as a hoe or as a double mould-board plough.

Besides these, others were constructed by Morton, of Edinburgh, Hawick, Brodie, Henry, and others.

Blakie's Horse-hoe.—This was the first implement that was successfully employed in hoeing between several rows of turnips at once; it was the invention of Mr. Blakie (author of a treatise on farm-yard manure), and was made by him while manager of the estates of the Earl of Leicester, and is the foundation of many of the most approved horse-hoes now in use.

Grant's Horse-hoe is a well-arranged implement, and an addition was afterwards made to it, by which all the hoes could be instantly raised, should they become choked with weeds or rubbish.

An immense variety of every description of horse-hoes are now to be met with at Agricultural Societies' meetings, and the farmer may there choose such as he considers best adapted to his land or peculiar manner of cultivation.

Among these the horse-hoes of Messrs. Garrett of Leiston, Mr. Smith of Kettering, Mr. Howard of Bedford, and Mr. Hensman, are conspicuous for possessing all the requisite qualities that should be met with in this description of implement. As nearly all the makers of agricultural machines manufacture horse-hoes of an approved character, it will be impossible to notice more than one or two of those whose improvements have brought them more prominently before the public than others, and foremost of these is—

GARRETT'S HORSE-HOE.

This is one of the most efficient implements of its kind, the greatest possible care having been taken by the Messrs.

Garrett to add to it every improvement that practice or theory shall have pointed out, to render it more perfect, and nearly everything that can possibly be required of such an instrument may be found in this machine. It has had prizes awarded to it at Liverpool, Bristol, Derby, Southampton, Northampton, York, Norwich, Exeter, and at the Great Exhibition, a Council medal.

Corn or roots of every kind, drilled in rows of not less than seven inches apart, may be hoed in a perfect manner, and at a cost, it is said, of about 6*d.* an acre.

"This implement," says the report of it in the *Journal of the Royal Agricultural Society*, "is so complete in itself, as to be fully suited to all methods of cultivation, whether broad, stitch, or ridge ploughing; and is adapted for hoeing corn of all sorts as well as roots. The peculiar advantages of this implement are as follow: it may be increased or diminished in size, to suit all lands or methods of planting; the axletree being moveable at both ends, either wheel may be expanded or contracted, so as always to be kept between the rows of the plants. The shafts are readily altered, and put to any part of the frame, so that the horses may either walk in the furrow, or in any direction to avoid injury to the crop. Each hoe works in a lever, independent of the others, so that no part of the surface to be cut, however uneven, can escape; and, in order to accommodate this implement for the consolidated earth of the wheat crop, and also the more loosened top of spring corn, roots, &c., the hoes are pressed in by different weights being hung upon each lever, and adjusted by keys or chains, to prevent them going beyond the proper depth. What has hitherto been an insuperable objection to the general use of the horse-hoe is over-ruled in this by the novel and easy method of steering, so that the hoes may be guided to the greatest nicety, if common caution be used, doing every execution among the weeds, without injury to the crop. This implement is so constructed, that the hoes may

be set to any width, from seven inches to any wider space. For the purpose of hoeing all kinds of corn, the inverted hoes only are preferred; but for the root crops, where the rows of plants are wider (say 16 inches or more), an extra hoe, of a semicircular form, is placed on a separate lever, working between and in advance of the two inverted hoes, for the more effectually cutting all the land, however uneven the surface, by the three separate hoes working independently of each other between the rows. The hoes are of peculiar improved manufacture, the blades being of steel, and made separate, and attached to a socket handle, in a simple and easy, yet effectual manner, so that any husbandman may replace them; and being manufactured by the patentees at an exceedingly low price, no difficulty can arise in replacing those parts subject to wear. In order to set the hoes in a proper cutting position, for either flat or stitch ploughing, and so as thoroughly to cut either hard or soft ground, the levers are put into a more or less oblique position, causing the cutting edges of the hoes to be more or less inclining downwards, by raising or lowering the jointed irons to which the forward ends of the levers are suspended and swung; which is done by merely moving the pin which rests upon the frame into different holes."

SMITH'S STEERAGE HORSE-HOE

Is one of the very best implements of the kind that I know of, and one that I should much recommend to small farmers as a cheap and truly efficient implement. It may be adapted to a variety of purposes, and the cost for one completely fitted up varies from 5*l.* to 7*l.* only.

It is so complete in itself, that it is fully suited to all sorts of drilled crops, either flat or ridged, and is adapted for hoeing wheat, barley, peas, beans, mangold-wurtzel, or turnips, at any given width that may be required.

The axletrees are made moveable at both ends, so that either wheel may be set further out, or closer in, thus adapting itself to keep between the rows of plants, and suit itself to all lands and methods of planting.

The person operating with this implement has the power of guiding it between the rows with the greatest nicety, and while thoroughly hoeing and tearing up the weeds, preventing the slightest injury being done to the plants, the steerage being quite independent of the horse, and so simple that any one may control it with the greatest ease.

The working depth of the hoes is regulated by placing the levers in a more or less oblique direction, which is done by merely moving the pin which goes through the shaft-iron into different holes, thus inclining the hoes more or less downwards, and better suiting it to cut either hard or soft ground. The width of the hoes is regulated by loosening the screws of the clip which fastens them upon the wrought iron bar or bars upon which they are placed. The two outside hoes may be placed parallel with the wheels, so as to cut the ground which they run upon. A seed drill can be attached, for sowing small seeds, and driven by a pulley on one of the wheels.

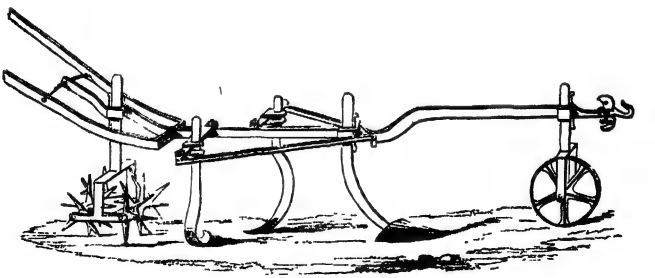
HOWARD'S HORSE-HOE

Is made entirely of wrought iron, and intended for one row of beans, peas, turnips, &c. It has three shares, which are made to slide upon the frame, so as to take the various widths required; it has two wheels fitted to a swing head, working upon a centre bolt, and the draught being central, the implement is not affected by any irregular motion of the horses. This arrangement, also, causes the implement to work much steadier.

HILL'S HORSE-HOE.

This is an expanding horse-hoe, invented by Edward Hill, of Brierly, near Dudley. It is intended for one row of turnips, beans, potatoes, &c., and has three shares, which can be expanded or constructed to the desired width by pressure upon the handles only, and which can be performed whilst the hoe is at work, with the greatest certainty as to distance. A small Norwegian harrow works behind the hoes, which not only has the effect of steadying the implement when at work, but which is also very effective in bringing weeds, &c., to the surface, and thus saving repeated hoeing, caused by weeds growing again when not brought effectually to the surface. The improvement consists in the slides of the hoe, upon which the wings work or expand, being placed upon, and in fact forming part of the wings, and sliding through the centre bar of the implement, so that these slides cannot project beyond the cutting parts of the implement. The above description is copied from the catalogue of the implement exhibited at the Lewes meeting of the Royal Agricultural Society.

Fig 18.



BUSBY'S HORSE-HOE.

Fig. 18 represents a most excellent implement of this

class, and one that has gained several prizes. It is shown so clearly in the wood-cut as not to require any further description. A portion of the stilts or handles have been removed to get it on the page.

CHAPTER IV.

MANURE DISTRIBUTORS.

A VARIETY of machines have been constructed for the purpose of distributing manure, both liquid and in a solid state.

For crops that are drilled, the best plan is to deposit the manure with the seed, as described in the chapter on drills; but as all crops are not drilled, and it is of importance to sow some manure broad-cast, ingenious contrivances have been made for effecting that purpose.

For the distribution of liquid manure, no system can equal the laying down mains (as practised by Mr. Huxtable, Mr. Mechi, and other gentlemen), and forcing the liquid through the pipes by force-pumps, worked by the steam-engine of the farm or some other motive power. Doubtless this may be very expensive in the first outlay, but I am satisfied it is the true plan, and will turn out the most economical in the end. When the practice of using manure liquid is better understood, and a hundred times the quantity used, which will be the case when the facilities (before alluded to) exist for distributing it, then not only will the liquid manure drained from the stalls and yards be sent to the land in a diluted state, but liquid manure will be manufactured by dissolving guano, and other concentrated manures, in water—carrying them to the land in this state instead of the ordinary plan of sowing—by which a very

large portion, the most valuable ingredients of the article, is lost. This fact is generally rendered pretty evident by the strong smell existing in the fields surrounding the one on which guano is being sown broad-cast. Drilling is doubtless a much more economical method, but this has its disadvantages, and cannot always be done.

Carts for distributing liquid manure are made by most agricultural implement-manufacturers of an efficient character, and at a moderate price. They are often fitted with pumps as part of the machine, and the best are made entirely of iron. An excellent specimen is made by Mr. Crosskill. The body of the cart is made entirely of iron plates, securely cemented and bolted together, and will contain about 100 gallons. It is fitted with a brass outlet valve, acted upon by an iron level rod, with which the driver opens and closes the valve, while walking by the side of the horse. The newly invented pendulum-spreading apparatus is attached, which regulates a sliding front adapted to water equally upon uneven land, six feet broad-cast; also, an improved apparatus for watering four rows of turnips at a time, by the use of four flexible tubes, guided by two lads with handles. By this means dissolved bones, and diluted sulphuric acid, or guano water, may be applied to water the ridges or rows any required width; an addition may be also made of one or two partitions inside across the cart-body to prevent the surging of the liquid upon uneven or bad roads. The objection to Crosskill's former cart was its not watering equally upon uneven lands, as when it passed over a slope or inclined surface the liquid naturally flowed to the lowest end of the fixed spreading board. By the improved method, the cart will water equally well whether the land be uneven or not. The apparatus being suspended to a pivot, with a regulating guide, it is fitted with pump and hose, and costs about 15*l*. It is an exceedingly complete thing, and one that can be recommended with safety.

Messrs. Deane, Dray, & Co., sell a manure tumbler cart, which is much approved of. It has a wrought iron body and is suspended between two wheels of 4 feet 6 inches diameter insuch a manner as to be filled and unloaded with great facility.

A very good liquid manure cart may be made by placing a barrel between a pair of Indian wheels. A tap at the back discharges the liquid into a trough placed cup-ways, and bored full of holes.

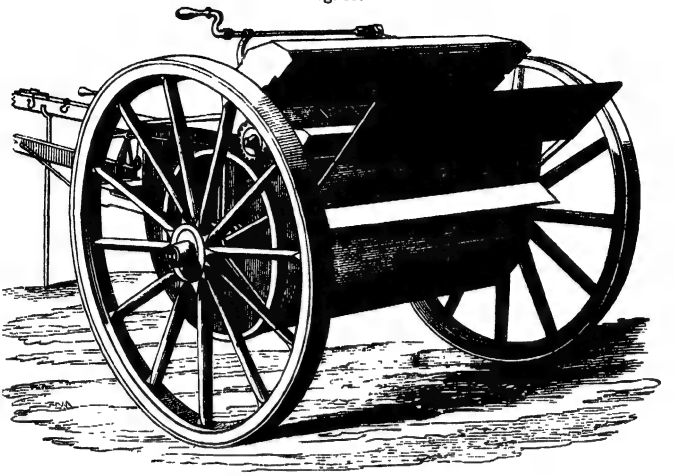
RLYTH'S BROAD-CAST MANURE DISTRIBUTOR.

This implement has been but recently introduced. It is manufactured by Garrett's, of Leiston, and gained a prize at Lewes. It is for the purpose of distributing regularly all kinds of natural and artificial manures, and the novelty consists in the arrangement of the machinery for the perfect delivery of those most difficult to distribute.

The manure is delivered from the box by means of a barrel, consisting of a shaft fitted with prongs, which carry over the manure, and, in doing so, it comes in contact with a series of scrapers, which rise with, and clean the barrel as it rotates the manure; then passing down the shoots, or conductors, it is evenly distributed all over the surface, or in rows, as may be required. The shoots, or conductors, are furnished with wire rods, fixed in alternate lines, giving them the effect of a sieve, whereby the manure is separated and pulverised as it falls.

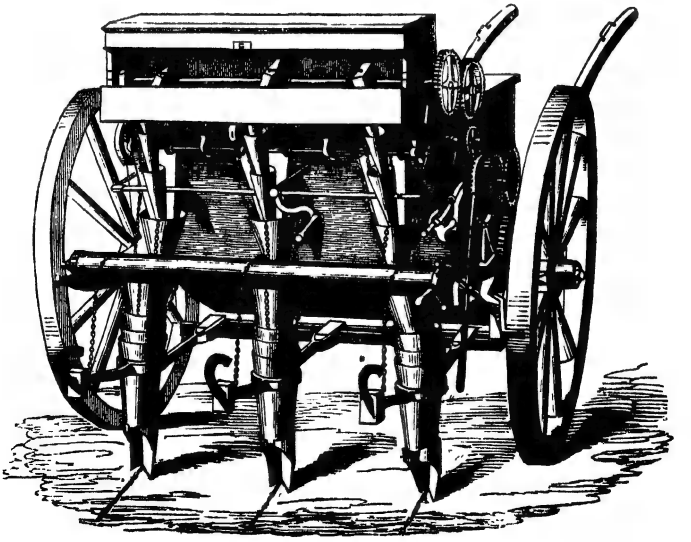
Chandler's Manure Distributor is represented in fig. 19. It is an excellent invention, and consists of three sets of buckets, working on an endless chain similar to chain pumps and dredging engines. The cistern will contain two and a half hogsheads, and will distribute from the smallest quantity to 40 hogsheads per acre. It has obtained several prizes, and is much in request. Straw, leaves, and other

Fig. 19.



CHANDLER'S MANURE DISTRIBUTOR.

Fig 20.



CHANDLER'S PATENT LIQUID MANURE DRILL.

matter that clogs most machines of this class, are, in this case, carried over with great facility.

CHANDLER'S PATENT LIQUID MANURE DRILL

Is on the same principle, and also much approved of. This machine will drill liquid with seed in any state of fluidity, and any quantity, from 3 to 10 hogsheads per acre; it will also distribute liquid manure broad-cast for top-dressings. It is the invention of Thomas Chandler, Esq., Aldburn, improved and manufactured by Thomas James Reeves, of Bratton, near Westbury, Wilts.

CHAPTER V.

SOWING MACHINES

Chiefly consist of drills. In the early history of agriculture sowing was all done broad-cast; indeed no other method would have suited the cultivation of the description of lands first sown with corn. Machines for the regular distribution of corn, or corn and special manures, have nevertheless been invented and used in the East from a very early date. The farmers of India, Japan, and Arabia have, from time immemorial, drilled and dibbled in their seeds.

The Chinese sowing machine of the present day resembles in some respects a hand barrow, and in others a small plough, and has three hollow teeth of about 28 inches in length, with iron supports, and carries the seeds in a box above the wheels, and drops them thence through the teeth to the ground in rows. It follows the plough, and is itself followed by a roller, which answers the purpose of a harrow. The Hindoos deposit the seed in a similar way. Gabriel

Platte describes a rude dibbling machine formed of iron pins, "made to play up and down like virginal jacks;" and about twenty years later, 1669, John Worlidge, in his "Husbandry," not only advocated the use of a seed-drill, but a manure-drill also. Evelyn strongly recommended the Sembrador drill-plough to Englishmen. This was the invention of a Spaniard, Don Joseph de Lescatello. It was fastened to the tail of a plough, and dropped the seed regularly in the furrow, and is said to have effected the sowing of a given area with a saving of about one-fifth of the seed usually deposited by broad-cast sowing. Some writers state that this machine was invented in Germany and carried from thence into Spain. It was in the latter country, however, that it attracted the notice of the Earl of Sandwich, the English ambassador, and he forwarded it to this country as a Spanish invention; but it seems to have been looked upon merely as an agricultural curiosity, and no regular use seems to have been made of it until Jethro Tull, in 1730, devoted all his abilities and energies to bring it into use, to more readily perfect and introduce his great idea, horse-hoeing husbandry. Tull, delighted with the advantage gained by the use of the two instruments, soon set about improving the sowing machine. His first invention was a kind of plough, with drill attached, for sowing wheat and turnips in three rows at a time; it consisted of two seed-boxes with a coulter attached to each, and following each other; behind them followed a harrow to cover in the seed. His object in having two separate deposits of seed, and at different depths, was that they might not sprout at the same time, and so perhaps escape the ravages of the fly. Tull also invented a turnip-drill, and in the cultivation of turnips his practice was more applicable than to wheat, for he was deceived by theoretic notions in reference to the capability of the soil to supply the food of the plants, and instead of carrying out an efficient system of drilling and hoeing, he

attempted to grow corn year after year on the same soil without manuring. His turnip-drill was similar to the other, but lighter. The feeding spout was so arranged as to carry one-half backwards after the earth had fallen into the channel; a harrow was pinned to the beam, and by this arrangement one-half of the seed sprung up sooner than the other, and so escaped the ravages of the turnip-fly. Tull adopted here for the first time the plan of having cavities formed in solid cylinders for the purpose of feeding.

Nothing more seems to have been done towards drill improvements until about forty years afterwards, when Sir James Anstruther introduced to the Bath and West of England Society one of his own invention, and which he had previously used for about eight years without its getting at all deranged. It was a double drill-plough, constructed for sowing two furrows at once, the horse walking between, that the soil might not be injured by the tread of the horse's feet.

During the next dozen years as many patents were taken out, two of which were for effecting the double operation of depositing both seed and manure at the same time; yet none of these came much into use until James Cooke, a clergyman of Heaton Norris, in Lancashire, invented the drill, upon which is founded all the machines now in use, for its principles are adopted, more or less, in every one of them. In Mr. Ransome's book is a cut of this drill, and the following description:—

"The seed-box is of a peculiar shape, the hinder part extending lower than the fore part. It is divided by partitions, and supported by adjustable bearings, so as to preserve a regular delivery of the seed, whilst the machine is passing over uneven ground. The feeding cylinder is made to revolve by a toothed wheel, which is fixed on each end of the main axle, and gears with other toothed wheels on each end of the cylinder; the surface of the cylinder is

furnished with a series of cups, which revolve with it, and are of various sizes, according to the different seeds intended to be sown. These deposit the seed regularly in funnels, the lower ends of which lead immediately behind the coulters, which are connected by a beam so as to be kept in an even line, and are capable of being held out of working when desired by a hook and link in the centre. The seed, as it is deposited, is covered in by a harrow fixed on behind. The carriage wheels are larger than usual, by which means the machine is more easily drawn over uneven ground, and the labour of working is reduced."

About the year 1790, Cooke's drill having found its way into Norfolk, fell into the hands of Henry Baldwin, a farmer living near Harleston, who, aided by a local workman named Samuel Wells, contrived several ingenious improvements to the machine, the first of which was in making a sliding axle-tree, by which the carriage-wheel could be extended when necessary to the width of the stitches, and so enable another box with cups and more coulters to be used. A drill containing fourteen coulters could be thus enlarged to contain eighteen, or even twenty.

He also constructed self-regulating levers, to which the coulters were attached; by hanging each coulter on a separate lever, each lever swinging by an ordinary hinge joint, and having a movable weight at the outer end to press the coulter into the soil to the required depth.

These two improvements are both in use at this day, and must have at the time very much advanced the reputation of the implement for efficiency and ability to work on land having an irregular surface, as the levers hanging independently of each other were able to adjust themselves to any irregularities they might meet without disturbing the whole machine, as was the case with the original Cooke's drill.

From this time the patents for improvements in drills

have been very numerous, and the competition in their manufacture at the present time among some of the most eminent agricultural implement makers brings into the market an immense variety of machines adapted to every conceivable requirement that peculiarity of land, style of farming, or description of seed or manure to be deposited, may suggest.

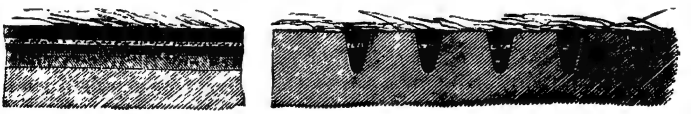
Before proceeding further with the subject of drills, it may be better perhaps if I describe in the shortest manner possible the principle and arrangements of the parts of the ordinary drill as in general use; for though there are a variety of ingenious mechanical contrivances attached, peculiar to each, yet the general arrangement is the same, as is the object for which each one of its class is constructed. The ordinary drill consists of an oblong box, mounted in a peculiar manner upon a carriage with large wheels; this box is divided longitudinally with a partition, thus making two compartments, the inner one being called the seed box, and the outer one the delivery box. In the seed box is placed the grain intended to be sown, and in the partition between the two boxes are a series of openings called pigeon-holes, through which the seed is allowed to pass into the delivery box, the quantity being regulated by small slides, which will be more particularly described hereafter.

In the bottom of the delivery box are a series of holes (communicating with pipes or shoots below); in these holes are placed small tin hoppers which stand a considerable height above the bottom. From end to end of the delivery box there is placed a spindle or small shaft, and upon this wrought iron discs, as many as there are holes in the bottom of the box. Projecting from the side of the discs are a series of small stalks, having at their outer ends little cups, thus forming a number of little spoons. By an arrangement of wheel work, connected with the wheels of the carriage of the machine, those discs are made to revolve along with the

shaft upon which they are placed, and in doing this they take up from the bottom of the box the seed which has been admitted from the seed box, and as they pass round, drop it into the hoppers before mentioned, through which it passes into a pipe, to be conveyed to the ground, where a proper place has been prepared for it by another portion of the machine.

Attached to a portion of the fore part of the carriage, by hinges, are a series of lever bars, upon which are placed coulters, numbering as many as there are pipes descending from the delivery box; weights are placed upon the levers to press the coulters into the ground to the desired depth; and as the machine moves forward, each coulter opens a little furrow, into which the seed from the pipe is deposited. Such a drill as I have described would merely deposit seed, but now that so much valuable artificial manure is used, drills are constructed to sow manure along with the seed. When this is the case, another box for the manure is provided, and an additional set of pipes, coulters, and other apparatus. The first coulter then opens a rut, into which the manure passes from the pipes; a forked piece of iron follows, which covers a little of the mould over the manure; the next coulter follows, and after it the seed is deposited in the manner shown in the annexed diagram.

Fig. 21.



The bottom stratum is the manure; above that a thin layer of mould, to prevent the manure and seed coming in contact; upon that the seed to be sown, and over that again some more earth; the seed then being placed in the most eligible state to be brought to maturity.

The operation of drilling may thus, by the most approved machines, be considered almost perfect; but it was by no means in that state when we left it as improved by Baldwin.

From that point it was taken in hand by two brothers, James and Jonathan Smyth, of Peasenhall and of Swefling, in Suffolk, "who (as stated by Mr. Ransome, in his book), in manufacturing this implement, for upwards of 40 years, brought it by their unremitting attention and ingenuity to the highest state of perfection," and Smyth's drills are, at the present time, considered as among the very best in use.

The improvements of these gentlemen were very numerous, but among the most important may be considered their improvements in the form of the manure box, trundle plates, and delivery cups; a mode of adjusting the distances between the coulters; *a swing steerage*, by which means the coulters could be forced from right to left or left to right, so as to preserve the parallelism of the lines for sowing the seed; and also the very important addition of *the apparatus for sowing manure and corn* and small seeds at the same time. Besides these, they also introduced some important improvements in driving the barrels, and adjusting the coulters, by means of the fluted roller and chain gearing now in common use.

Following upon these improvements of the Smyths, Messrs. Garrett have considerably improved this machine, by making the ends of the machine of iron instead of wood, as well as some better arrangements for changing the speed-wheels, also the adding another wheel to the opposite end of the machine, which equalises the velocity of the delivery cups, in ascending and descending hills, one wheel being used for going up, and the other for coming down; also a regulating screw, to raise and lower the box, and arrangement for extending or contracting the width of the drill.

Messrs. Hornsby have also much improved some of the details of their drills, by the introduction of some ingenious

contrivances: 1st. For regulating the position of the boxes while the machine is on sideling ground. This is done by means of a long screw, worked by a winch at one end, and secured by two bearings; two small arms, the upper ends of which are attached to the end of the box, and the lower ones work upon the screw, which, as it turns, brings the arms nearer together, or removes them farther apart, thus lowering or raising the box, as may be required, with the greatest nicety.

2ndly. A swing steerage, which allows of the coulters being maintained in a straight line with the greatest ease, and is worked by double handles attached to a toothed segment, and giving the operator great power over the machine.

3rdly. In a better arrangement for regulating the supply of seed from the seed box to the delivery box by means of a small shaft, having a cog-wheel placed at every aperture, or pigeon-hole. These act upon small racks in the manner of sluices, and regulate the supply with ease, certainty, and accuracy.

4thly. In the introduction of vulcanised India-rubber tubes, instead of a succession of conical tins, for conveying the seed from the delivery box to the ground. These tubes are said to be much superior to the tins when drilling in windy and rainy weather.

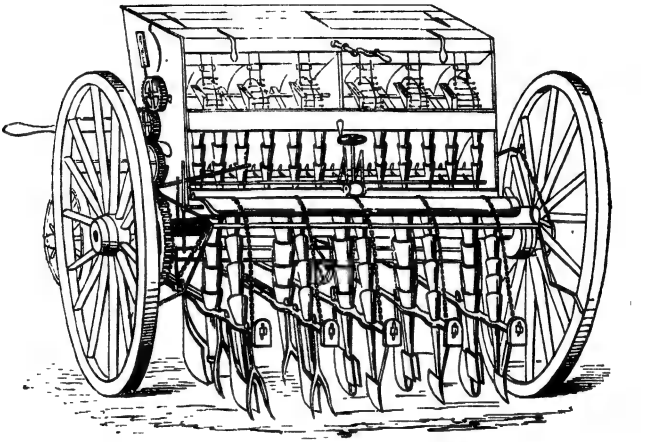
The use of flexible tubes is not new, as leather tubes have frequently been tried, but were found to wear out too rapidly. Mr. Hornsby's improvement consists in the application of vulcanised Indian-rubber for this purpose.

GARRETT'S GENERAL-PURPOSE DRILL.

Fig. 22 represents the general-purpose drill of Messrs. Garrett, and it is considered one of the very best drills manufactured, Messrs. Garrett having bestowed great pains

in perfecting this implement by adding every improvement that practice could suggest for rendering it more effective.

Fig. 22.



It is adapted for performing all the various operations of seeding and manuring the land. All kinds of grain and seeds may be deposited at any required distances apart, and at any depth, either with or without compost or artificial manures.

They are constructed of various widths, and made to deposit the seed in rows from six to fifteen in number, and to suit all descriptions of land, whether ploughed flat or in ridges. The corn and manure are sometimes sown through the same delivery tubes, but it is better when double tubes and coulters are adopted, as the seed is then buried two or three inches deeper than the seed (as before described), and a portion of mould placed between the two. The boxes are suspended on a centre in the middle of the machine, and may be elevated or depressed, at either end, by means of a lever, so as to keep them at all times in a horizontal position,

and to insure a regular delivery of both on hilly as well as flat lands. This arrangement admits of the barrels, which deliver the manure and seeds, being driven by gear at the ends of the boxes in the usual way, thus avoiding all unnecessary complication.

Besides the general-purpose drill, Messrs. Garrett construct a great variety of this class of machines adapted to the various requirements of the agriculturists; and, although the general-purpose drill fully deserves its name, yet, when the farm is large, it is much better to have other machines made expressly for the purpose. Among these may be mentioned:—

A Drill for Turnips and Manure on the Flat, which deposits two or three or four rows of turnip or other seeds, with compost or artificial manures, on either flat or ridge ploughed lands. This machine is fitted with separate seed boxes for each row, placed on a horizontal bar, and may be shifted to suit the intervals between the drills, so as to come directly over the delivery spouts, and allow the conductors to work freely. The boxes are partitioned off into two compartments, one larger than the other, so that when drilling beet and turnip seeds together, sufficient of each to last an equal time may be put into the boxes at once. An apparatus is also provided for regulating the level of the seed and manure boxes.

An economical Three-row Drill for Turnips, &c., with Manure on the Flat or Ridge.—It is a cheap and efficient machine for drilling turnips, mangold-wurtzel, &c., with rape-cake dust, guano, Irish peat charcoal, or any light pulverised material. It is calculated for two rows from 20 to 28 inches apart, or three rows at 16 inches apart, and the quantity of seed may be delivered as required—say, for turnips, 1 to 6 lb. per acre; and beet seeds, 3 to 8 lb. per acre — the former being delivered by the action of brushes, and the latter by a revolving barrel. The

quantity of manure may be regulated from 2 to 24 bushels per acre.

This machine comprises most of the important features of the more expensive implements. It is 4 feet wide, and 36 feet 8 inches high, and weighs about 3 cwt. The cost does not exceed 13*l*.

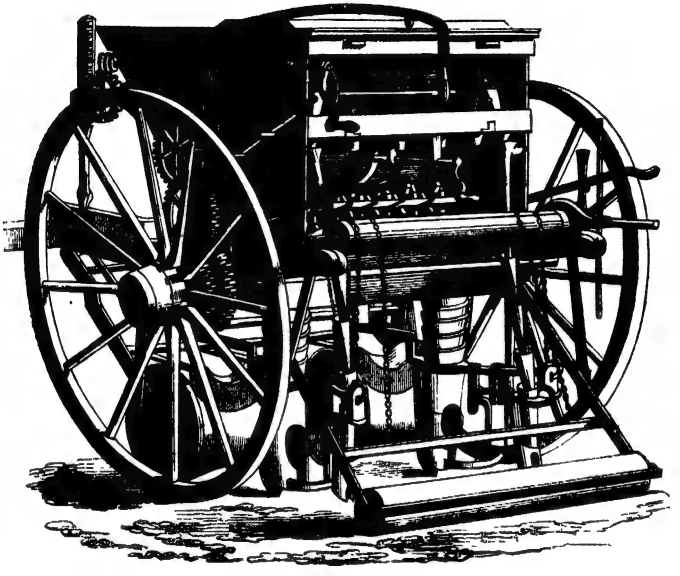
Hornsby's General-purpose Drill.—This is an efficient machine, having been much improved by Messrs. Hornsby in the manner before alluded to—that is in the plan of adjusting the box on sideling ground, in the substitution of India-rubber tubes for the old tin conductors, the regulating the supply of seed from the seed to the delivery box in the swing steerage, and in a great variety of other minor details. It is capable of drilling every kind of seed and corn, with or without manure, in any required quantities, and at any distance apart. Both seed and manure can be regulated while the drill travels. The agitator in the manure-chamber is so arranged that the man who follows can, by simply moving a lever, put it in or out of action without stopping the progress of the machine.

An improvement has been also made by having two coulter bars, by which arrangement the weights upon the ends of the levers have exactly the same pressure upon every coulter, thereby depositing the seed at an uniform depth.

Messrs. Hornsby, like Messrs. Garrett, manufacture every other description of drill, adapted to large or small farms, for the various kinds of seed and methods of sowing. Fig. 23 represents the *Two-row Ridge Drill* by this firm, which received a prize at the Great Exhibition of 1851. It has adapted to it various improvements for regularly delivering both seed and manure, the same as in the general-purpose drill; and equal facility is afforded for altering the quantity of manure it is depositing as it travels forward. The manure coulters are placed before the concave rollers; the ridges

are then brought into the proper form, and the seed is

Fig 23.



deposited and followed by the second rollers, leaving the ridges perfect.

HENSMAN'S DRILL.

This is often called the Bedfordshire drill; it was originally invented by Robert Salmon, of Woburn, but has been much improved by other parties since—first by two brothers named Bachelor, machinists, residing at Lidlington, near Bedford, and by Smith, of Kempston, but more particularly by Mr. Hensman.

It is an efficient little implement, but is not adapted to the variety of purposes that the other kind of drills are.

A modification of this is constructed by William Hensman & Son, of Woburn, who received a silver medal for it at the York meeting, in 1848, and a prize medal at the Great Exhibition.

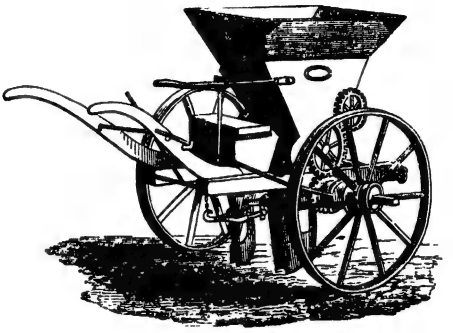
This machine has several peculiarities, in which it differs materially from the generality of other drills. *First*, that the carriage rests upon the coulters instead of the coulters hanging from the carriage: the coulters are similar in form to a skate, and are in consequence very effective in penetrating hard ground, and in giving a firm bed to wheat sown in soft. The axletrees are made to slide, so that the wheels can be set to any width. *Secondly.* In the manner in which the seed box, &c., is supported between two standards, which give great facility for balancing it. A lever is placed through an aperture in the centre of the box for striking the barrel in and out of gear, and a very ingenious contrivance is adopted for adjusting the varying length of the driving shaft. A seed box is made to fix on the corn box, for the purpose of sowing clover and other small seeds broadcast at the same time as barley is being drilled; or it may be attached without the corn box, and used for sowing turnips or other small seeds; or it may be converted into a horse-hoe, by attaching hoes to the levers instead of coulter shares.

HORNSBY'S DRILL FOR SMALL OCCUPIERS.

This is a very simple and cheap machine, and well adapted to the wants of small occupiers; it is made to work on the ridge, and deposit turnip or mangold-wurtzel seed, with or without manures; it may be fitted with rollers before and after the manure coulter, with a double-actioned lever. The manure and seed coulter act independently of each other; the manure can be deposited deep, and covered, and the seed at a shallower depth, as in the large and more expensive

implements. Two-row ridge-drills of the same character are also made by the same house.

Fig. 24.



HORNSBY'S DRILL FOR SMALL OCCUPIERS.

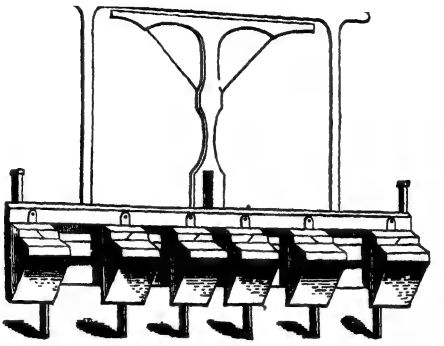
DROP DRILLS.

Of these several varieties exist; they are for the purpose of depositing the seed in patches, and fixed intervals apart, and more resembling the action of dibbling than drilling. They are constructed in many respects similar to ordinary drills, but with this difference, that they have at the bottom of the delivery-spouts a chamber containing a valve, which regulates the egress of the seed in the manner before described.

SEED MACHINES

Are long triangular-shaped boxes, having a small shaft running through them; upon this are fitted a number of little brushes, which, as they revolve, force the seed through apertures in the fore-side of the box, which is carried on a small barrow, on which it is laid crosswise.

Fig. 25



DIBBLING MACHINES.

It is the general opinion of the best judges that dibbled crops are much superior to those drilled, but machines for effecting this desirable object are by no means in such a state as could be wished, although many ingenious and really useful machines have been invented and constructed by different individuals; amongst the most prominent of whom is the gentleman whose hand-dibbling machine we have engraved.

In the *Journal of the Royal Agricultural Society*, is a report of Newberry's dibbler. The judges say, "We have examined the effects of Mr. Newberry's dibbling machine, and have no hesitation in reporting the superiority of the wheat crops where the seed had been planted by that instrument, over those which have been sown broad-cast or drilled." We must not omit mentioning the very ingenious machine exhibited at the Great Exhibition, called the walking dibbler.

CHAPTER VI.

REAPING MACHINES.

Upon no implement (of late years) has so much attention been concentrated as upon reaping machines. There have been trials in almost every country; while newspapers, who seldom condescend to notice the progress of agricultural mechanics, gave whole columns to the reports of them, practical farmers paid the greatest possible amount of attention to the subject, offered every facility for the trials, gave judgment upon their respective merits, with a candour and fairness that does them infinite credit.

The great excitement (for it arrived at that), about reaping machines was in consequence of the success of two exhibited by Americans, named M'Cormick and Hussey, and who, I believe, might have exhibited anywhere else, again and again, without notice; but nothing in the Great Exhibition of 1851 escaped proper notice, great or small; whether it was the ponderous 68-pounder cannon of the Low Moor Iron Company, or the minutest portion of the machinery of a watch, it was sure to be seen, appreciated, and talked about by those who were interested in it: and the general public, who seldom trouble themselves about what does not immediately concern them, made up their minds in this case to examine everything, and try to understand them, if possible. Ladies were seen underneath locomotive engines, examining cranks, connecting rods, and eccentric gear, on one side of the building, or hurting themselves and damaging their clothes with spiky rollers, harrows, grubbers, scarifiers, and

pulverisers, on the other. Not a little either was due to the *Times* newspaper who, in much over-praising the American productions of reaping machines, and a fast-sailing yacht, calculated on giving a hard rub to the supineness of their special friends the farmers and shipowners: and in the case of farmers they were perfectly right—not in the superior ability of American mechanics, but in the shrewdness of that people in calling to their aid machinery constructed to cheapen the cost of agricultural operations; for, will it be believed, that the best reaping machine was invented in England many years ago, and although it was most regularly exhibited at Agricultural Societies' Meetings, and had premiums awarded to it, yet neither the farmers nor the agricultural implement-makers would have anything to do with it, and the thing was utterly neglected. I of course allude to Bell's machine, publicly exhibited in 1828. As a proof that little attention has been paid to this machine, I made some trifling experiments on a corn reaping machine in 1847, and was so led to see what had been done in the way of such machines. On meeting with an eminent agricultural implement-maker soon after, I inquired if he knew anything about reaping machines, and whether Bell's would at all answer in practice; he at once assured me that there was nothing of the kind in existence that would work half an hour without getting broken to pieces, and that Bell's machine was only an ingenious contrivance, but utterly worthless for any practical purpose, so I did nothing more in reaping machines. Six years after, at the Smithfield Club Show, in Baker Street, (that is, last Christmas,) I saw this same gentleman, and at once took him to look at Bell's reaping machine, made by Crosskill, of Beverley, and adopted by him as being on a better plan than any other, he being a maker of one of the American machines. My mechanical friend was obliged to admit, on my reminding him of our previous conversations, that he knew nothing about it, and

had only seen a print of it in a book, and thought it would not work, so took no further heed of it. This, I expect, is about the case with farmers and machine makers generally. The farmers set their face against new things, and the makers devote a much larger proportion of their time and abilities in puffing up and selling their goods than they do in endeavouring to improve them, and invent new ones to meet the new and improved systems of agriculture.

Reaping machines are by no means the recent inventions some persons imagine, as it is certain that machinery of some kind was used by the Romans for cutting corn, as frequent mention is made of them by the early writers; but whatever description of implement it might be, it certainly did not come into general use, nor was it introduced into England that I am aware of.

The first attempt at a reaping machine seems to have been made about sixty years since, by a person named Boyce; this machine was placed in a two-wheeled carriage, something resembling a cart, the axle revolving with the wheels. The cutting action received its motion from this, by a contrivance of wheel-work, and consisted of a series of scythes fixed to an upright shaft; these revolving horizontally, cut the corn, but left it lying in so rough a state that little advantage was got from it.

The next attempt seems to have been made by a London millwright, named Plunket; this was an improvement on Boyce's, as instead of cutting with scythes, he had a horizontal circular plate, jagged on the edge like a sickle. This was found to cut tolerably well, but was inefficient in other respects, and a better machine was constructed by a Scotchman named Gladstone, of Castle Douglas, in the stewartry of Kirkcudbright, the cutting principle being similar, but a contrivance added, by which the corn was collected and held in its place until cut by the circular revolving plate, and afterwards raked it off and laid it in patches upon the ground behind

the machine. Another feature in it was the placing a small circular wheel of wood covered with emery, this was kept in contact with the cutting wheel, at the opposite side to that employed in cutting, thus keeping the edge constantly sharpened.

That ingenious person, Salmon, of Woburn, next tried his hand at a reaping machine, and adopted an entirely new principle, for it should be remembered, before his time all the machines cut by a revolving circular plate, or disc, or scythes. *Salmon was the first to apply the cutting action of shears*, which appears to be the best principle, as the approved modern machines are so constructed, his reaper also laid it down in parcels as it was cut.

SMITH'S REAPING MACHINE.

This was designed by J. Smith, of the Deanstone Works, Perthshire, whose name is now very familiar in agricultural matters. This machine consisted of a circular drum, upon the lower edge of which, projecting from the periphery some inches, was a cutting blade; the drum and cutter were placed upon an upright shaft, fixed to the fore-part of the carriage of the machine; this was supported by two wheels fixed to the axle, on which were placed bevil gear acting upon a horizontal shaft, which drove the drum and cutter.

The drum received the stalks of corn upon its surface, and being some distance round, were thrown off in a regular row. The machine was propelled by two horses, attached to a pole in the rear of the machine, the horses pushing it in front of them. It cut an English acre in about an hour, during which time the cutter required to be sharpened four times with a scythe stone.

Mr. Smith persevered with his machine from 1811 to 1815, but at last abandoned it, having too great calls upon his time in other directions.

BELL'S REAPING MACHINE.

We come now to a very important point in the history of reaping machines, that is, the invention of the Rev. Patrick Bell. It appears that this gentleman's attention was drawn to the subject of such machines while at Cambridge, and that some years afterwards he constructed one for his own use. This machine was tried at Powrie, in the county of Forfar, in 1828, and its capabilities witnessed by a large number of persons. About fifty gentlemen and farmers, all interested in agriculture, signed a declaration, stating that the machine cut down a breadth of 5 feet at once, was moved by a single horse, and was attended by from six to eight persons, to tie up the corn, and that the field was reaped by this force at the rate of an imperial acre per hour.

In September, 1829, this machine was tried in the presence of a still greater number of persons, at Monckie, in Forfarshire, who attest that in half an hour it cut half an English acre of a very heavy crop of oats, which were lodged, thrown about by the wind, and exceedingly difficult to harvest.

It was tried in a number of other places in Forfarshire, Fifeshire, and Perthshire, and the general conviction appeared to be, that it would soon come into as general use as the threshing machine. But this was not the case, for nothing more was heard of it (except in its immediate locality, where, I believe, it continued to be used for some years,) until 1851, when the Great Exhibition of all Nations, as I have before mentioned, drew attention to machines for reaping corn. So slow had been the introduction of new machines, that, although this valuable implement had been invented in Scotland for twenty-three years, not one person south of the Tweed, that I ever heard of, had adopted it, and but very

few ever knew that such a thing had been invented. A few attempts had, it is true, been made during this time in England, but not with success, and all these were upon the horizontal disc plan.

To describe Bell's reaper, so as to be understood without a drawing, is almost impossible, and the limits of this book, and the number of cuts already given, prevent my giving one; but those who desire to learn more of the matter than they will find in these pages, will find a good description, with illustration, in "Loudon's Encyclopædia of Agriculture."

Bell's reaper consisted, in its original state, of a square framework of wood, forming a kind of carriage, which was supported on two broad-tired wheels of good diameter. The axle upon which these wheels hung passed through the machine, the wheels worked loose upon it; but, by means of clutches at each end, the wheels could be made to give motion to the axle when required. The lower part of the framing projected forward some distance, and was supported at the end by two solid wooden wheels of much smaller diameter than the principal ones. In front of these wheels, and attached to the carriage by iron arms, was fixed a bar of wood, called the "fixed bar," and upon this was screwed a row of triangular blades, something like (in shape) to the pointed blade of a pair of scissors, and called the "fixed cutters." Between the machine and this outer fixed bar was another bar, upon which were placed a row of blades, or cutters, similar to the others, except that they were lengthened by a piece of iron reaching from the outer fixed bar to the inner or movable bar. Between each o. the fixed cutters was placed one of those movable, and secured by a pin to the fixed bar.

Upon the axle of the carriage was placed a cog-wheel which, with other gear very ingeniously contrived, gave motion to the inner bar, causing the movable cutters to pass from right to left, and left to right, over those that

were fixed, thus producing a cutting action similar in every respect to a pair of shears.

Projecting from the machine at the top and over the cutters was another framework of a light character, and upon this was placed a light reel, formed by placing a flat spar of wood from one extremity to the other, of two arms which projected from a light spindle, the two ends of which were supported on either side of the projecting framing; as there were twelve of these arms, there were consequently six vanes, or wings, to the reel. The use of this was to press upon the mass of standing corn, and hold it steadily up to the machine while it was being cut by the cutters below.

This reel was made to revolve at a moderate speed by means of bevilled gear, worked from the wheel on the main axle to a small shaft, in the end of which was a pulley, which gave motion to a corresponding one on the end of the reel by means of a gut-line, or strap. From the outer end of the projecting lower frame-work to the end of the principal upper frame, were placed on either side two solid wooden rollers, thus forming an angle with the ground of about forty-five degrees. An endless cloth passed over these two rollers, and as they revolved (by the action of an endless chain passing round two pulleys, one at the bottom of each), the wheat, after being cut, was carried away to the side, and deposited in a row by the side of the machine.

Such is a slight description of this ingenious implement. All the different circumstances under which the machine may be used have been provided for by its ingenious inventor, and the machine had been brought to a point of perfection that is quite astonishing, considering that this was nearly the first attempt at a machine that performed all the necessary operations, and was actually the first in use upon the shears' principle.

Nothing much was done in reaping machines from this

time (1830) until 1850, with the exception of some attempts by Mr. Hornsby, and by Smith, of Deanston, but they were only experiments.

For the Royal Agricultural Society's show, held at Exeter, in 1850, the enterprising firm of Garrett & Son, of the Leiston Works, Saxmundham, Suffolk, prepared a machine for reaping corn, and took it to Exeter, but through some informality it was not admitted.

This machine was the invention of Obed Hussey, of Baltimore, U. S. A., and was the first American machine introduced into England. The plan of it was suggested to the manufacturers by J. Tolemache, Esq., M.P. for South Cheshire. This gentleman had seen the machine at work in America, and was so struck with its merits as to advise the Messrs. Garrett to commence the construction of such machines for the use of English farmers. The result of this advice was the production of the machine taken to Exeter, and called by the makers the Tolemache Reaping Machine. The next year (1851) brought forth the Great Exhibition, and this machine was taken there by the manufacturers, and placed among the various machines at their stand.

In the American department, there had also been placed two other reaping machines—one invented and exhibited by M'Cormick, and the other by Obed Hussey. We will now proceed to describe these machines, and the trials made of them separately.

Fig. 27 represents the side elevation of M'Cormick's machine; fig. 26 the plan of the same, and fig. 28 enlarged parts to show the cutting action more clearly.

M'CORMICK'S REAPING MACHINE.

The best possible description of this machine is the specification itself.

Fig. 26.—Plan.

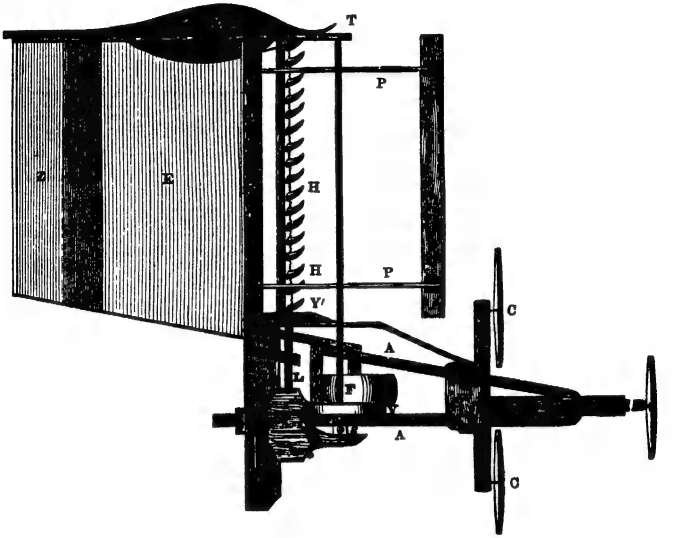


Fig. 27.—Elevation.

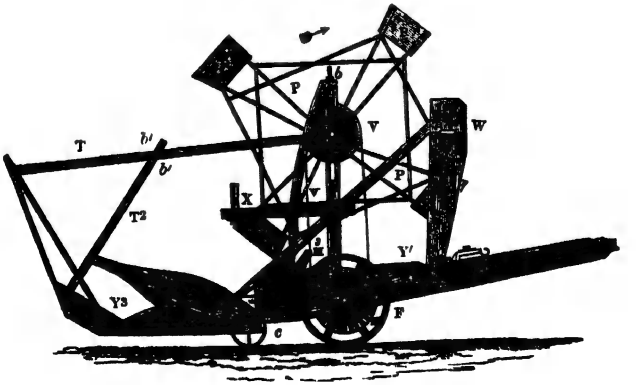
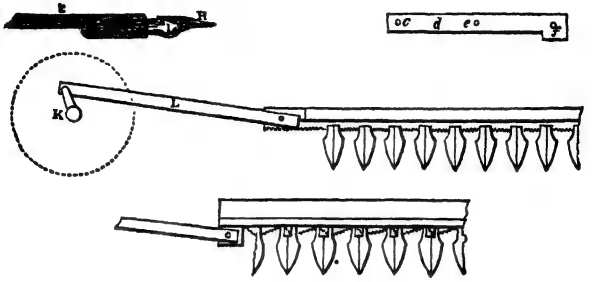


Fig. 28.



" SPECIFICATION.

" This invention has special relation to that class of machines which are worked by horses in cutting or reaping wheat, corn, or other grain, and has for its object the better holding of the stalks of the grain in a favourable position, while being cut and the more conveniently arranging, collecting and disposing of the same when cut.

" Fig. 1, is side elevation, and fig. 2, a plan of a reaping machine constructed according to the said invention; A A is a frame of wood of a triangular form, to the front of which there are fixed the pole B, and whipple-trees C C. The back rail D, of the frame is prolonged on one side of the machine, so as to project about six feet beyond the frame, and the projecting portion forms the basis of a platform E; F and G are two wheels upon which the machine is mounted. The wheel F (from its position) bears the greater portion of the weight of the machine, and is employed for communicating motion to the moving parts, as afterwards described. H H H, are a set of fingers somewhat of a spear-head shape, which are affixed to the front edge of the platform, and placed at regular intervals apart from each other. Immediately underneath these fingers is placed the cutting blade I, which is formed of a thin plate of steel, toothed upon its front edge and fitted

into a groove, or into bearings attached to the front of the platform. Fig. 3 is a cross section of the rail D, and the cutting-blade I, showing the method of attaching the fingers H H to the front of the platform, and their relation to the cutting-blade. This blade has perfect freedom to slide from one side of the machine to the other, but the amount of range given to it is limited by the crank K, to which it is attached by means of a connecting rod L; M 1, is a bevil wheel which is keyed to the shaft of the wheel F, so that both may revolve together and give motion to a bevil pinion. M 2 and wheel M 3, which are fixed to an intermediate shaft N. The wheel M 3, gears into a pinion O placed on the crank shaft and consequently gives motion to the crank K, the connecting rod L, and the cutting blade I. The number of teeth of the intermediate gearing which has just been described are so proportioned and adjusted that the cutting blade may reciprocate and do its work very rapidly; P P is a large reel or gatherer, which is of very light construction, and carries at its extremities four blades R R R R, made of thin deal. At the near side of the machine this reel is supported by an upright S, and at the off-side by a brace T, which is raised upon the back of the platform. When the machine is going forward, the reel is made to revolve in the direction indicated by the arrow, by means of a band or belt U, which takes on to the hem of the bevil wheel M and the rigger V, the latter of which is keyed to the reel shaft. The distance of the reel from the platform is capable of being adjusted by means of the sliding bearing (upon the near side of the machine) which is acted upon by the screwed rod *b*. At the further side the brace T is fixed to the spur T 2 by means of a movable bolt, so that the brace may be raised or lowered at pleasure, by passing the movable bolt into any one of the holes (*b' b'*) further up or down in the spur. W is a seat for the driver, and X a seat for the person gathering the reaped grain from the platform.

"When the machine just described is applied to the cutting of wheat or other grain, it is brought to the edge of the field (with either two or four horses yoked to it) and with the platform placed in front, and the horses alongside of the crop to be cut down. As the horses advance, the wheel gearing is put in motion, which causes the reel slowly to revolve, and so prevent the straws or stalks from being pressed forward when they come in contact with the cutting-blade, which has at the same time a rapid reciprocating motion imparted to it by the action of the crank K and connecting rod L; the straws or stalks are thus speedily cut through, and fall backwards on the platform. The fingers H, H, H, greatly facilitate this part of the operation, as they hold the straws or stalks from yielding along with the lateral action of the cutting-blade; and it is for the more effectually accomplishing this object that they are formed of a shape like to a spear-head, which causes the straws or stalks to slide into the spaces between them when in that position, and as the inclined edges at the roots of the fingers (that is, immediately over the cutting blade) form an acute angle with the edge of the knife, the cutting through of the straws or stalks is sure to be effected by the reciprocating movement of the knife-blade. Two separate views of parts of the fingers and cutting blade are given in figs. 4 and 5, the blade in fig. 4 is straight in the cutting edge, while that in fig. 5 is zig-zag, or of an indented form."

HUSSEY'S REAPING MACHINE.

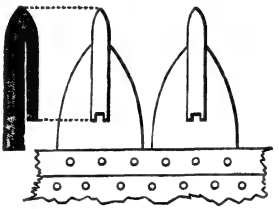
As Manufactured by Garrett.

This is the implement before alluded to, as having been copied by Messrs. Garrett more than a year before. The cutting action in this is quite different from that of M'Cormick's, and may be considered a modification of Bell's. The corn is cut by a series of triangular knives, placed on a

Fig. 29.—GARRETT'S REAPING MACHINE, UPON HUSSEY'S PRINCIPLE.

horizontal sliding bar, intersecting or working between a like series of iron tines, which are fixed to a wooden platform, provided to receive the corn as it falls. Motion is communicated to the knives by means of a crank and shaft worked by the revolution of the travelling wheel of the machine; as the implement proceeds in its work, the corn is received and cut between the knives and tines and falls on the stage, from which it is raked off at intervals by the man in attendance for that purpose.

Fig. 30.



CUTTERS OF HUSSEY'S REAPING MACHINE.

A trial of these machines being decided on by the jury of the class to which they belonged, they were accordingly conveyed to Tip Tree Hall farm, belonging to Mr. Mechi.

Mr. M'Cormick was there to attend to his own machine, and work it under his own superintendance, but Mr. Hussey's machine had no such advantage, being superintended by one of the Exhibition porters. The result was exactly what might have been expected: M'Cormick got the prize medal, and a vast amount of credit, and Hussey's condemnation and neglect that it did not deserve; in fact, the trial at Mr. Mechi's was not worth the name of a trial, and the hasty award of the medal to M'Cormick is among the least just decisions of the juries; nevertheless, practical men and machine manufacturers were generally favourable to Hussey's principle, and considered that, if the machine was

not then in a perfect state, it was capable of being easily rendered so.

Mr. Hussey at length arrived in England, to attend to his own invention, and the thing quickly began to assume another complexion, in consequence of which Messrs. Dean, Dray, & Co. of Swan Lane, London Bridge, made some arrangement with Mr. Hussey for the right to manufacture his machines in England. Mr. Crosskill of Beverley undertook their manufacture, and these machines having achieved some successes .that got noised about, Messrs. Burgess & Key of Newgate Street placed in the public papers the following challenge:—

"Public Challenge to Makers and Vendors of Reaping Machines.—We the undersigned agents for Mr. M'Cormick, having observed sundry advertisements and circulars complaining of the decision of the Jurors of the Great Exhibition of 1851, in favour of Mr. M'Cormick's reaper, and of the reports given in the public journals of the trials which led to such decision, do hereby give notice to Messrs. Wm. Dray & Co., Messrs. Garrett & Son, Mr. O. Hussey, and all other makers and vendors of reaping machines whatsoever, that M'Cormick's Reaper will be tried at the Cleveland Society's Show at Marton, Middlesborough, near Stockton-on-Tees, on the 25th inst, and publicly challenge them, or any of them, to meet us there with their machines, for the purpose of a comparative trial of the respective merits of each, to be determined by the Chairman and Council of the Cleveland Society, or by such judge or judges as the said Society may appoint.—Burgess & Key, 103, Newgate Street, London."

The challenge was immediately accepted, and both it and the reply extensively circulated.

"In answer to an advertisement which appeared in the *Times* of the 18th, from Messrs. Burgess & Key, giving us a public challenge to a trial of the American reaping

machines, we hereby announce that we shall willingly accept the same, and on the 25th inst. shall be prepared, at the Cleveland Society's Show, Marton, Middlesborough, near Stockton-on-Tees, to prove to the agricultural world the superiority of Hussey's Reaper, for general farming purposes. We stipulate, however, that the machines shall be tested, not only on a particular patch of good upstanding grain, where they might perhaps prove equal, but on an average variety of condition, as to short and laid corn, &c., such as a farmer will usually meet with. Its capabilities for cutting green crops, such as clover, &c., shall also be proved. It must be evident to the farming public that the reaping machine which will cut a crop of the greatest variety and difference of condition must possess the greatest merit. —Wm. Dray & Co., Agricultural Implement Warehouse, Swan Lane, London Bridge."

Accordingly, the matter was arranged, and the following gentlemen were called upon to act as jurors :—

Henry Stephen Thompson, Esq., of Moat Hall, foreman; Mr. William Lister, of Dunsa Bank; Mr. John Booth, of Killerby; Mr. John Parrington, of Brancepeth; Mr. William Wetherell, of Kirkbridge, Darlington; Mr. Robert Hymers, of Marton; Mr. Christopher Debson, of Linthorpe; Mr. Robert Fawcitt, of Ormsby; Mr. Joseph Parrington, of Cross Beck; Mr. John Outhwaite, of Bainesse; Mr. George Read, of Hutton Low Cross; Mr. Thomas Phillips, of Helmsley; and Mr. Thomas Outhwaite, of Bainesse.

The following were the conditions to be submitted to by the representatives of the respective machines :—

The machines to be tried on wheat and barley, in such order and for such length of time as the jurymen may direct. The jury to have full power to use any means they may deem advisable in order to put the machines to the severest trials. The jury, in deciding on the merits of the two machines to take into their consideration,

1. Which of the two cuts the corn in the best manner. 2. Which of the two causes the least waste. 3. Which does the most work in a given time. 4. Which leaves the cut corn in the best order for gathering and binding. 5. Which is the best adapted for ridge and furrow. 6. Which is the least liable to get out of repair. 7. Which at first cost is less price. 8. Which requires the least amount of horse labour. 9. Which requires the least amount of manual labour. And whichever of the two machines so tried and tested has in it combined the greater number of the above qualifications, according to the opinions of a majority of the jury, it is to be pronounced the best implement. The trial which took place is thus described in the *Gateshead Observer* of the 27th ult.:—

"Great interest centered in the Middlesborough Agricultural Meeting of the present week. Mr. Philip Pusey, M.P., observed indeed to one of his northern friends, that the people of Cleveland could not feel more deeply interested this year in their own meeting, than did the agriculturists of England generally—a fact attributable, first, to the intention of Mr. M'Cormick's agents, Messrs. Burgess & Key, of Newgate Street, London, to exhibit his American reaping machine at the Marton ordeal. Secondly, to the challenge which they had given to Messrs. Dray, Hussey, & Garrett, to meet them in the field; and, thirdly, to the acceptance of that challenge on the part of 'Hussey's American Reaper,' by the inventor's agents, Messrs. William Dray & Co., of Swan Lane, Upper Thames Street, London.

"It was expected that the competition would have attracted a brilliant company to the ground, and so without doubt it would have done, had the elements been propitious; but the climate of England, proverbially fickle, attains its wayward maximum in Cleveland; and thus it happened that a drought of unusual duration (extending to three months) chose to terminate on the very day appointed for the competition,

and celebrated its breaking up by an outburst of rain, such as is seldom witnessed, even under the Yorkshire Hills. The drought had left the land so hard that the ploughs could not be tried, and the rain marred, to a considerable extent, the trial of the remaining implements.

"Despite the weather, however, there was a considerable muster at the appointed place—the farm of Mr. Robert Fawcitt, an agriculturist who combines science with practice, in the neighbourhood of Marton and Ormesby, his fields fronting the lodge-gates of Sir William Pennyman, Bart.

"We observed amongst the company several of the leading gentlemen and farmers of the district; and Mr. Counsellor Addison was present as a 'spectator.' After the trial of various implements, the reaping machines were tried; of fair weather there was no prospect, the only change was from foul to fouler, and foulest. It was now in the second degree. The implement jury left Mr. Fawcitt's with other farmers, and moved off to a field of wheat, where the rival 'reapers' were standing side by side. Mr. M'Cormick's machine was described in our last number. Mr. Hussey's is less complex in appearance. There is a seat on one side for an attendant, elevated above a level platform. The cutting machine mows down the wheat, and it falls back upon the platform, whence the attendant casts it on the stubble behind, and the labourers bind it into sheaves, and stack it. Mr. Hussey, the inventor, was present, and so also were representatives of the firm of Dray & Co., likewise Mr. Crosskill, of clod-crushing celebrity. It was curious to see on the soil of a Cleveland farm two implements of agriculture, lying side by side in rivalry, respectively marked 'M'Cormick, Inventor, Chicago, Illinois;' 'Hussey, Inventor, Baltimore, Maryland,'—American competing with American on English ground! Mr. Hussey led off; an attempt was made to keep back the eager crowd, but their curiosity was irrepressible—they flocked in upon the machine, so that the

experiment could not be properly performed, nor could the jury duly discharge their duties. Police constable Thompson did his very best—he was all but everywhere at once; but what avails a police force of one strong, against a concourse of Yorkshire yeomanry and clowns? It was requisite that he should have recruits, and a body of 'specials' came to his aid, who succeeded in procuring some approach to a clear course. Mr. Hussey then took his seat anew. This machine cut down a breadth of wheat from end to end of the field. It seemed to us to do its work neatly and well. The wheat was cleverly delivered from the teeth of the reaper, and handed over to the binders by the rake.

"But the weather was now at its foulest, and we could make no nice examination of the work. A high wind and a driving rain cleared the ground more effectually than Police-constable Thompson and his 'specials.' The cry at the head of the field was 'the nearest way out.' The Cleveland rustics, weatherproof, laughed at the townsfolk, and jeeringly replied, 'Put yeer heads on t' croon o' t' fence, an' tope ower in tit lane!' Without quite performing a summerset, we cleared the hedge, and waited not to see the conclusion of the contest. We soon learned, however, that the stormy blast and the descending deluge had cut short the experiment. Mr. M'Cormick's machine, it was said by some, made no commencement of a trial. Others reported that an attempt was made, but the horses could not contend with the storm, nor could the machinery be brought into effective action."

The unfavourable state of the weather during this trial was considered to have prevented the judges forming a sound judgment upon the two machines, another trial was therefore fixed for the following Saturday, and the result was again in favour of Hussey. The machines were tested on a crop of wheat, computed at 25 bushels per acre, very much laid, and on barley at 25 bushels per acre, very short in the straw, and, if possible, more laid than the wheat. The jury,

taking the different points submitted to their consideration in the order agreed, reported as follows:—

"1. That it was their unanimous opinion that Hussey's machine cut the corn in the best manner, especially across ridge and furrow, and when the machine was working in the direction the corn laid.

"2. By a majority of eleven to one that it caused the least waste.

"3. Taking the breadth of the two machines into consideration, that Hussey's did most work.

"4. That Hussey's machine left the corn in the best order for gathering and binding. This question was submitted to the labourers employed on the occasion, and decided by them, as above, by a majority of 6 to 4.

"5. Their unanimous opinion that Hussey's machine is best adapted for ridge and furrow.

"6. This question was referred by the jury to Mr. Robinson, foreman to Messrs. Bellerby, of York, a practical mechanic of acknowledged ability, whose report is appended below.

"7. That Mr. Hussey's machine at first cost is less price.

"8—9. The jury decline to express a decided opinion on these points in consequence of the state of the weather.

"The trials took place on the farm of Mr. Robert Fawcitt, of Ormesby, near Middlesboro'-on-Tees, who allowed his crops to be trodden down and damaged to a very great extent, especially on the 25th, when, in spite of the storm, an immense crowd assembled to witness the trials.

"The jury cannot conclude their report without expressing the great pleasure they have derived from seeing two machines brought into competition that were able to do such very good work, and also at witnessing the friendly, straightforward, and honourable way in which the exhibitors of the respective machines met on this occasion.

"Signed on behalf of the jury,

"W. F. WHARTON, *Foreman.*"

Mr. Robinson's Report on Question 6.

"Having carefully examined both machines, and given the subject due consideration, I am of opinion that M'Cormick's reaping machine, as at present made, is most liable to get out of order.

"(Signed) THOMAS ROBINSON.

"YORK, *September* 30*th*, 1851."

The following letter, written by a person who witnessed the trials, and addressed to Messrs. Dray, may give a better idea of them than could be communicated in any other way:—

"STOCKTON-ON-TEES, *September* 27*th*, 1851.

"SIR,

"Having been in communication with you relative to the trial of your reaper against M'Cormick's, and feeling deeply interested in the introduction of new implements into this district—particularly one of so much importance as a reaping machine—I think it is not probably out of place in me if I give you the result of my observations during the two trials which have taken place. From the fact that M'Cormick's machine obtained the prize at the Great Exhibition (though I do not *pin my faith* upon awards made by agricultural and other societies), the letter of Mr. Pusey's in the *Royal Agricultural Society's Journal*, the various newspaper reports, &c. &c., it was natural for me to be predisposed in favour of M'Cormick's machine; indeed, Mr. M. had a prestige in his favour, which, of course, operated against the 'Little Hussey.' Previous to starting at Marton, on Thursday, the gentlemen representing M'Cormick's machine expressed themselves desirous of testing the machines early in the morning when the dew was on, believing that their machine would cut the grain, under such circumstances, and that yours would not. Well, on Thursday we had a deluge

of rain, the surface of the land was very soft, and the corn very wet. Everybody there was astonished to see your machine brought up the field at a trot, cutting its way to the admiration of all present; it not only cut to the leaning corn, but it cut across over the corn leaning to the left of the postillion (I presume I must call him). M'Cormick's machine then attempted to start (he made two or three attempts), but the attendant confessed it was impossible to do so. That there might be no mistake about it, your representatives proposed that their machine should go up again. The jury said, 'No! We are satisfied that your machine can cut it under the present circumstances;' and so ended Thursday's trial. That the public might have every opportunity of examining the machine, it was very properly, I think, brought into the show-yard on Friday, and, in the midst of a *pelting rain*, exhibited its movements to the public.

"As per arrangement of the jury, the trial was resumed this morning. On entering the field, the corn was found to be not sufficiently dry to cut; in fact, the jury decided to wait until the corn was in such a state that the occupier of the field considered it would be prudent to cut it without risk of injury from the tying-up. This, then, was *a clear test of the practical merits* of the machines. M'Cormick's machine started first, cutting the wheat leaning towards the machine. The crop was so much laid from the rains that the 'reel' was of no avail—indeed it was quite *inoperative;* however, the corn was fairly cut through. The stubble was not left so level as to be called good work, and it was not cut so near the ground as is usually the practice here with the sickle, or scythe; but I suppose the machine can be altered to cut lower. The sheaves were laid tolerably even for binding. It appeared to me that, to fill the office of raker-off, was no little difficulty—I mean that it required great exertion. Under some circumstances, the plan of raking off

from the side is a great advantage; then the rule, I believe, generally is to bind as it is cut.

"The machine sent by you was then set to work, and it must have been evident to all that the cutting principle is superior to the other machine. The stubble was left more regular in height, and it was cut much closer. If it had a fault, it was too close: there were no 'longs and shorts,' as a countryman observed. The sheaves, too, were laid more regular for tying-up. The jury then requested the machine to be tried cross over the corn, leaning to the left hand of the man driving; here, again, the work was very fair indeed —*far better* than the people present anticipated. To the astonishment of many, an attempt was also made to cut the wheat laid *nearly flat from the machine*, and really in some parts of the field it cut very fair, in others leaving the stubble very much too high. If the wheat had been quite dry, and free from weed at bottom, I believe that, even under such a very unfavourable state, the machine, if attended by a skilful attendant, would have cut and laid the corn quite satisfactorily.

"M'Cormick then made an attempt to cut across the corn leaning as described above—indeed the cut was along side that made by your machine. As the farmers present said, there was no 'sight in it,' the stubble was cut *so very irregular*; indeed, it was quite clear to my mind that the cutting arrangements of M'Cormick's machine are defective. It requires the straw to be *held to* the knife before it will cut it. It would be difficult to cut a *loose* hair with a very sharp penknife, but a pair of scissors rather blunt would cut it. This simile applies, I think, to M'Cormick's and Hussey's machines.

"M'Cormick's machine was then set to cut the wheat leaning from the machine, in the same situation as Hussey's. In this case there was a *complete failure;* indeed, the knives passed over the wheat, occasionally cutting off the heads. If

a doubt lurked in the minds of any one as to the merits of the two machines, this failure of M'Cormick's settled the point in favour of Hussey.

"A trial was then made on barley by Hussey's machine, and it cut very satisfactorily. Mr. Fawcitt took Mr. Hussey's seat to rake off the sheaves, which he managed very well. Some said he would soon beat Mr. Hussey himself.

"I had not an opportunity of seeing M'Cormick's machine at work on the barley, but I believe that it did not work so satisfactorily as on the wheat.

"I shall be happy to answer you any questions you may ask me on this subject. Wishing you the success you deserve in introducing such a valuable machine,

"I am, respectfully yours,

"JOHN PALMER."

Both M'Cormick's and Hussey's machines have since this period received many improvements; the former an arrangement for cutting closer to the ground than formerly, and Hussey's in an improved form of knife by Messrs. Garrett, which much improves its cutting action.

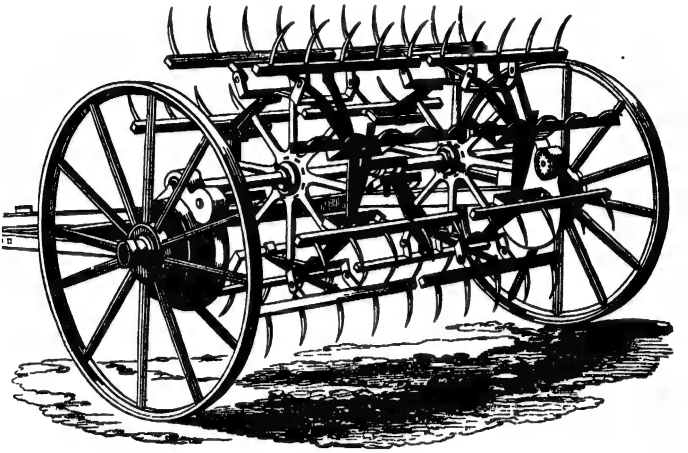
Bell's Reaping Machine.—In 1852, at the Smithfield Club Show, held in Baker-street, last Christmas, Mr. Bell's reaping machine was exhibited by Mr. Crosskill, who had made arrangements with Mr. Bell to construct it for him, and thus have the American reaping machines, about which there has been so much talk, been superseded by an English one invented thirty years before.

HAY-MAKING MACHINES, OR HAY-TEDDING MACHINE.

This was invented by Salmon, of Woburn, about the year 1816, and has been modified and improved by several persons

since. Fig. 31 represents one of these machines as constructed by Wedlake, of Horncastle, Essex.

Fig 31.



It consists of a skeleton cylinder, with a series of rakes placed upon it, which revolve as the wheels of the carriage upon which it is placed move forwards. Wedlake's improvement consisted in making the cylinder in two parts, with motion independent of each other, and in so adjusting the teeth upon a spring-supported bar, that they yield to any sudden inequality in the ground, and immediately afterwards return to their ordinary position. An arrangement also exists for pushing back the implement without turning the rakes, and for raising them from the ground and keeping them there while the machine is travelling from place to place, or for a few seconds.

The tedding of hay is most efficiently done by these machines, and they are great favourites with the Middlesex farmers, and are extensively used in large parks in various parts of the country. They are manufactured by most

implement-makers, some having greater celebrity than others; among these, Messrs. Barrett, Exall, & Co., of Reading; Garretts, of Leiston; and particularly Smith and Co., of Stamford, who have made several improvements, which bring this implement to be an almost perfect machine.

RAKES.

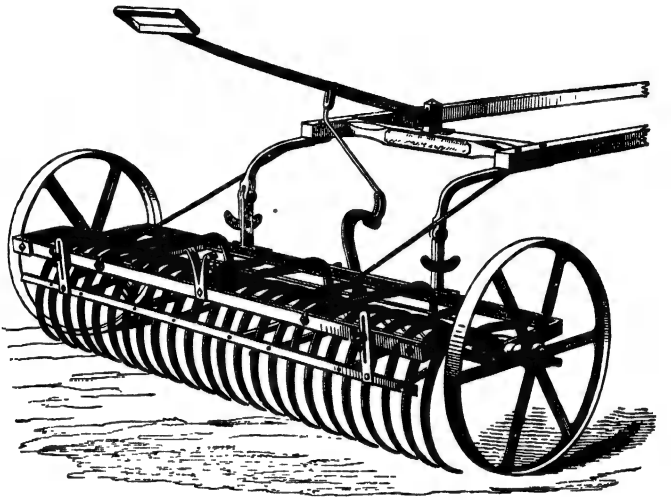
An instrument for raking the ground has doubtless existed from the most remote times, as the earliest operations upon land were little better than a scratching of the soil, such as might be performed with an implement of this description; and ordinary rakes are of so simple a construction as to require no description here.

The Drag-Rake is a larger kind of the ordinary rake, the cross head which carries the teeth being made large, with a row of deep curved teeth placed in it. The teeth should be of steel, and fixed with screws, to allow of their being easily replaced when broken out or injured. Sometimes wheels are placed at the ends of the cross heads, to render them more portable. When still further increased in size, they are drawn by a horse, and are in that state most valuable and useful implements, and much used on fallows to extract the couch grass and other rubbish, and in harvesting they are employed in raking up the loose corn, &c.

One of the earliest efficient implements of this kind is known as the Suffolk drag rake; it consisted of a row of prongs, supported at either end by wheels, and a simple apparatus, by which the prongs could be lifted up at once when required, but as the prongs were all fixed fast in the cross head which carried them, they were very likely to get broken, and in the modern improved horse drag-rakes this difficulty is entirely overcome, the implement having received a series of improvements from various persons, among whom Mr. Sayer of Bodham, Norfolk, and Mr. J. C. Grant of

Stamford, are conspicuous. Fig. 32 represents one of the best now in use.

Fig. 32.



HOWARD'S HORSE DRAG-RAKE

Is one of the best implements of this kind; a prize was awarded to it at Exeter, in 1850, by the Royal Agricultural Society, and again, it gained a prize at the Great Exhibition of all Nations. It is thus described by the makers: "It is intended for raking hay, corn, stubble, or twitch grass. The shaft irons are furnished with a joint and quadrant, by which the teeth may be readily altered, so as to rake upon their points, or set more or less off the ground. This method is to prevent the rake collecting the soil and rubbish with corn, an objection frequently raised against the use of horse-rakes; the teeth being curved or sickle-formed, are much stronger than when angular, and the hay and corn works round them

much more freely; the bar running under the teeth, and by which they are raised, is so arranged that the teeth do not, as in other rakes, rest upon it, but allow them to drop into any hollow parts of the land. The frame and teeth are made entirely of wrought iron; the teeth work independently of each other, so as to adapt themselves to the irregularity of the surface. It is mounted on high wheels, which are capped, to prevent the hay, &c., working round the axles.

By means of a simple pull-down lever, which requires only the strength of a boy to manage, the rake can be easily emptied of its load, without stopping the horse; the frame being made of iron instead of wood, the wheels are brought about a foot nearer to each other, which is a great advantage on narrow farm-roads, and in passing through gateways.

An improvement has also been made in this rake by the introduction of a plan to raise or lower the lower handle, to suit the height of the person employed to empty it, which avoids the necessity of stooping when relieving it of its load. This implement is useful in dragging meadows after a flood, and raking in clover seed in the spring.

Biddell's Patent Corn-Gatherer is an implement of unquestionable utility, as it much facilitates the operations of harvesting. It will enable a company of harvest men to begin loading when the corn is dry, without the usual delay, while corn is being raked into heaps, or, as they are called in Suffolk, "shocks," for pitching. In the busy time of harvest it saves manual labour, not only in gathering up swathes (without stopping the horse), but the corn when so gathered being compressed, may more readily be pitched, and a greater quantity be loaded upon a wagon, and got into the same barn room, than if raked together in the usual way. In the implements usually constructed for the above purposes, a great difficulty has been experienced in unloading, and it required the application of great strength to lift them

over the gathered heaps. One swathe is gathered at a time, and the load is left without its being lifted up.

It is constructed with three rows of tines, fixed to an axle, supported at either end by wheels. The tines are similar in shape to those of a horse-rake, and one of the three rows alternately begins to gather the swathe as soon as the previous one has finished its heap, the size of which may be regulated as required.—Messrs. Dean, Dray & Co., are the agents for the sale of the implement.

CARTS AND WAGONS.

Carts, like most other agricultural machines, vary in their form and construction, according to the nature and peculiarity of the roads upon which they have to travel, or the particular character of load they are to carry.

That any advantage is to be got from using the old-fashioned heavy carts and wagons that are found in many localities, is a mistake; yet many farmers of my acquaintance still persist in purchasing these unsightly and abominable productions, made by village wheelwrights, who are entirely ignorant of the true principles upon which carriages ought to be made. Many of these old wagons and carts were perhaps tolerably well suited to the state of the roads in times far back, but, during the last 50 years, not only have the great turnpike roads which connect one market with another, but the parish roads also, been brought to an exceedingly good state, and it is now only the green lanes and farm roads (which depend upon the farmers themselves) that are to be found in a state such as to require the carriages that travel upon them to be constructed in such a cumbrous manner.

Great facility for removing manure from the steading, and carrying the produce of the fields back to the homestead, is now as necessary as the lands and buildings themselves, as

is also the means of conveying the produce of the farm to market; for it must be remembered always, that those great growers of corn in distant countries, with whom the English farmer has now to compete, have an immense advantage over him, in the facilities they possess in carrying their farm produce by water to distant towns and markets, as the site of many of the great American and other corn-growing districts is upon the banks of great inland lakes and large rivers.

We have no space in this little book to enter at length into the question of wheel carriages, nor can it be properly considered as part of the subject under notice.

That carts possess many advantages over wagons is now pretty generally believed, and is proved by the fact, that wherever any large amount of work has to be done, carts only are employed, as a horse, when drawing singly, will do half as much more work than when acting with another; as alone he has nothing but his load to contend with, whereas when two are pulling, a considerable amount of power is lost in their pulling in different directions, and more or less at particular moments. Three horses will certainly do more work in single horse carts, than four in two-horse carts, and when the work is regular, and along tolerably even roads, a great saving will take place with one and two-horse carts as compared with wagons with three and four horses, though for very long journeys, and peculiar descriptions of merchandise, wagons properly constructed may be preferable, but this case does not apply to the farmer. In Scotland one and two-horse carts only are used, and the same is the case throughout all the best cultivated districts of England. In shifting earth, and in the carriage of building materials, contractors and builders always employ one or two-horse carts, and never wagons. Harvesting may also be done with carts, properly constructed, better than in any other way.

Carts and wagons are now constructed by most agricul-

tural machinists, with every attention to strength and lightness, while the peculiarities of any particular locality are carefully considered, should any such exist. The formation of the wheels being the most important part of the cart or wagon, a factory has been established by Mr. Crosskill of Beverley and Liverpool for manufacturing his improved wheels; these are sold in sets to the local makers, who mount the cart and wagon bodies of their make upon them, and great benefit and superiority of the carriage is obtained; it being impossible for small makers to compete in price with Mr. Crosskill in the construction of wheels, where everything is done on a large scale, and the parts made with mathematical accuracy. Wheels of any size are made by machinery, constructed expressly for the purpose. They have iron naves, called balled naves. The arms are turned perfectly true by self-adjusting machinery, and after being case-hardened, are fitted complete to a wrought iron axle. The spokes are made of well-seasoned English oak, driven into the naves by a powerful machine, and then fitted into a lathe, for turning the end of each double-shanked spoke to fit into double-shouldered sockets, bored with equal precision in the felloes, which are of ash, sawn out, segmented, and turned by machinery. The hoop-tires are bent, cut, bevilled, fitted, and hooped in the same manner.

CROSSKILL'S MODEL ONE-HORSE CART.

This is perhaps one of the very best specimens of a cart that could be found, and is particularly recommended, as a generally useful one, and adapted better than any other for the everyday wants of the farmer. They run exceedingly light and easy with heavy loads, and are equally well adapted for the farm roads as they are for those macadamised; everything is constructed with a view to economise materials, and acquire lightness without sacrificing strength. It is fitted

with the patent wheels, tire 2½ by ¼, and every requisite for rendering it generally useful, while the price is not more than for one of the clumsy contrivances of the village wheelwright. About thirteen pounds is the price of one to carry 30 cwt., and fitted complete with harvest shelvings or staves.

They are made of a variety of sizes, to carry from 30 cwt. to 60 cwt. Some of them have strong springs, portable covers and seats, self-acting tailboards, &c.

FARM RAILWAYS.

But little has at present been done towards the general introduction of farm railways; nevertheless some of the leading agriculturists have laid them down, and express themselves much pleased with the result.

Mr. Crosskill, of Beverley, has contrived a system of railway that is at once extremely cheap, durable, and portable, with turntables, points, and curved pieces complete; at once forming a most admirable substitute for the bad roads, lumbering waggons, clumsy carts, and teams of heavy horses that are always to be met with on English farms, only half loaded, yet up to their knees and axles in mud and earth, and doing but little work, while consuming much valuable time. The railway of Mr. Crosskill is constructed in lengths of 15 feet by 2 feet 11 inches wide, and 2 feet 6 inches in gauge; the ends fitting into iron sockets.

The rails are of wood (the best red deal), edged with iron, and strongly put together.

The trucks are made to carry about 10 or 15 cwt. of turnips, and are especially adapted for carrying manure, marl, lime, &c., and removing every description of root-crop.

It can be removed or laid down with the greatest facility, as two active boys will move it one hundred yards further

on, and replace it, in less than ten minutes. To reduce the cost for delivery, by rail or vessel, the rails are packed up for delivery in packages 15 feet long, 12 inches square, and weighing 4¾ cwt.

Sets of ironwork only are supplied where parties may wish to use their own timber.

Cost of a Portable Farm Railway, to carry 15 *cwt. Loads.*

	£	s.	d.
100 yards, or 20 lengths of rail at 2*s.* 6*d.* per yard	12	10	0
Truck with end tipper	5	0	0
Truck to tip on either side	5	0	0
1 turntable	5	0	0
	27	10	0

Extras.

2 sets of points with double rails 15 feet long	5	0	0
2 sets of double rails to join the double lines, each 15 feet long	3	0	0
2 turning curves to join a double line, each 10 feet long	1	0	0
4 turning curves, to branch off the straight line	2	0	0
	38	10	0

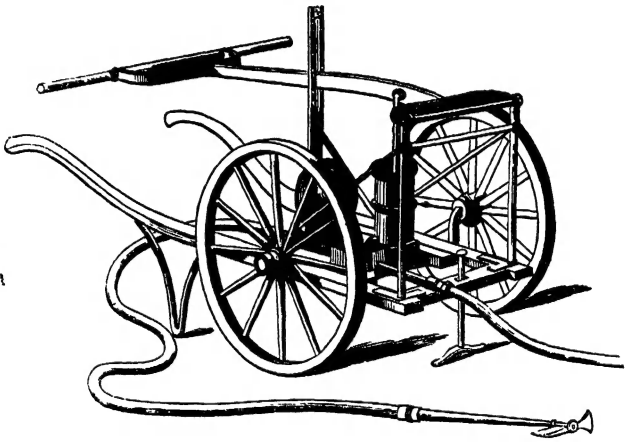
Cost of a Permanent and Portable Farm Railway, to carry 40 *cwt. Loads.*

Mr. Crosskill will engage to lay permanent rails with wood sleepers, fitted three feet in gauge, including all materials and labour, except carriage and one man's travelling expenses, per yard	0	5	0
Portable rails with wood sleepers, in 12 feet lengths, fitted 3 feet in gauge, for two men to carry and lay down from the permanent rails across any part of the field, at per yard	0	4	6
A double line, with sets of points, curves, and entire connecting rails, about 55 yards run, at per yard	0	10	0
Sets of ironwork, for one 15 feet length, with dry nails, per yard	0	2	6

	£	s.	d.
Sets of wheels and axles, for railway trucks, each set .	3	10	0
Turntables for gateways of any field, or homestead entrances	7	10	0
Trucks to carry 40 cwt. of earth, manure, &c. . . .	7	10	0
Trucks with harvest frames, complete	9	10	0

Cuttings, embankments, or any other earthwork to be done by the owners or occupiers of the land.

Fig. 33.



BADDELEY'S FIRE-ENGINE AND LIQUID MANURE PUMP.

This is an exceedingly efficient machine, answering both the purpose of a fire-engine and a pump for spreading or forcing liquid manure on the land. It is manufactured by Merryweather, of Long Acre, for the inventor.

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